

BOONTON

BOONTON ELECTRONICS CORPORATION



MP MASTER



MA24286



INSTRUCTION MANUAL

MODEL 1110

PROGRAMMABLE

AUDIO OSCILLATOR

NO incl. Theory^{of} operation

BOONTON

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SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This instruction manual provides installation, operation and maintenance instructions, parts list and schematics for the Model 1110 Audio Oscillator.

1-3. DESCRIPTION.

1-4. The Model 1110 is a versatile, precision, solid-state instrument with features and performance characteristics especially suited to laboratory and industrial applications. Human engineering considerations have been emphasized in both the mechanical and electrical design of the Model 1110. The result is an audio oscillator that is easy and convenient to use. Among the outstanding features are:

a. **Versatile Performance.** Advanced generation techniques enable the Model 1110 to provide accurate, low distortion signals. Demanding applications are satisfied by the high output power capability, wide frequency range and selectable output impedance.

b. **Separate Displays of All Major Functions.** The Model 1110 has 3 separate display windows to simultaneously present amplitude, frequency and program number or bus address information. Continuous display of IEEE-488 bus status is also presented.

c. **Ultra-low Distortion.** The mark of quality for any audio oscillator is spectral purity. The total harmonic distortion of the Model 1110 is specified as less than 0.01 % with typical performance an order of magnitude better than specified.

d. **Versatile Output.** The Model 1110 features wide control over its output configurations. Source impedance can be set to 50, 150, or 600 ohms in either a floating or single-ended configuration. All source impedances are available at the same set of output connectors, eliminating the need to multiplex separate 50 ohm and high impedance outputs.

e. **Sweep Operation.** Frequency or level can be swept in user-selected linear or logarithmic steps over any portion of the range. Rear panel X axis and PEN outputs are provided for plotter application.

f. **Instrument Setup Memory.** Up to 99 front panel setups containing all data required to configure the instru-

ment to a previous operating mode can be stored in non-volatile memory for future recall. The last valid instrument setup before power interruption is also saved automatically and restored when power is resumed.

g. **IEEE-488 Interface Bus.** All instrument functions are programmable except bus address. Annunciators to the left of the BUS/PRGM display window show the status of bus activity. The 1110 is designed to interface easily with controllers currently in use. A versatile free-form number entry system is used so that the 1110 will accept any conceivable valid number string. Triggering may be performed in immediate or wait modes. There are six talk modes which can be addressed in either the remote or local state. The 1110 also provides a choice of several end-of-string terminators. Service-request (SRQ) can be asserted on errors or using the front panel SRQ key and the LCL/INIT key will force return to local control when using the bus as long as a lockout message has not been sent.

1-5. ACCESSORIES.

1-6. The following accessories are supplied with the instrument:

AC power cord
Spare output fuses

The following accessories are available:

950044	Rack mounting hardware
950043	Chassis slide kit
95401801A	Single binding post to BNC (M) adapter
95401901A	BNC (F) to phono plug
95402001A	Phono jack to BNC (M)
95402104A	Two conductor shielded balanced line, 36"
95402201A	XLR connector to three banana plugs

1-7. OPTIONS.

1-8. The following option is available:

-01 Rear panel output connectors

1-9. SPECIFICATIONS.

1-10. Performance specifications for the Model 1110 Audio Oscillator are listed in Table 1-1.

TABLE 1-1. PERFORMANCE SPECIFICATIONS.

SOURCE SPECIFICATIONS

Frequency

Range: 10 Hz to 150 kHz

Resolution:

0.001 Hz; 10.000 to 199.999 Hz

0.01 Hz; 200.00 to 1999.99 Hz

0.1 Hz; 2.0000 to 19.9999 kHz

1.0 Hz; 20.000 to 150.000 kHz

Accuracy: 10 ppm + 1 count

Timebase

Type: 10 MHz TCXO

Accuracy: + - 1 ppm/yr

Level

Range: 0.01 mV to 16.000 V rms, open circuit

Full Scale Ranges:

16.000 V, 3.000 V, 300.0 mV, 30.00 mV

Accuracy (settings from 0.60 mV to 16.000 V):

+ - 0.5 % of setting + 0.05 % of range;

10 Hz to 50 kHz

+ - 1.0 % of setting + 0.05 % of range;

50 kHz to 100 kHz

+ - 1.5 % of setting + 0.1 % of range;

100 kHz to 150 kHz

Flatness, ref 1 kHz (0.30 mV to 8 V into 50 ohms):

+ - 0.5 %; 10 Hz to 50 kHz

+ - 1.0 %; 10 Hz to 100 kHz

+ - 1.5 %; 10 Hz to 150 kHz

Output

Impedance:

50 ohms + - 2 %

150 ohms + - 1 %

600 ohms + - 1 %

Distortion and Noise (the greater of):

0.01 % (-80 dB) or 10 uV;

10 Hz to 20 kHz, 80 kHz bandwidth

0.02 % (-74 dB) or 20 uV;

20 to 50 kHz, 220 kHz bandwidth

0.056 % (-65 dB) or 50 uV;

50 to 100 kHz, 500 kHz bandwidth

0.1 % (-60 dB) or 50 uV;

100 to 150 kHz, 500 kHz bandwidth

Output Power (50 ohm source):

31.07 dBm (8.00 V) into 50 ohm load

29.82 dBm (12.00 V) into 150 ohm load

25.60 dBm (14.76 V) into 600 ohm load

SUPPLEMENTAL INFORMATION

General Information

Power Requirements:

100, 120, 220, 240 volts AC, 50 to 400 Hz, 60 VA

Operating Temperature:

0 to 55 degrees centigrade

Dimensions:

17.75 inches (45.1 cm) wide, 5.85 inches (14.9 cm)

high, 18 inches (45.8 cm) deep

Weight: 25 lbs (11.3 kg)

Accessories Included:

Spare output fuses and AC power cord

Accessories Available:

950044 Rack mounting hardware

950043 Chassis slide kit

954018 Single binding post to BNC (M)

954019 BNC (F) to phono plug

954020 Phono jack to BNC (M)

954021 Two conductor shielded balanced line, 36 "

954022 XLR Audio connector to three banana

plugs

Options:

-01 Rear panel output

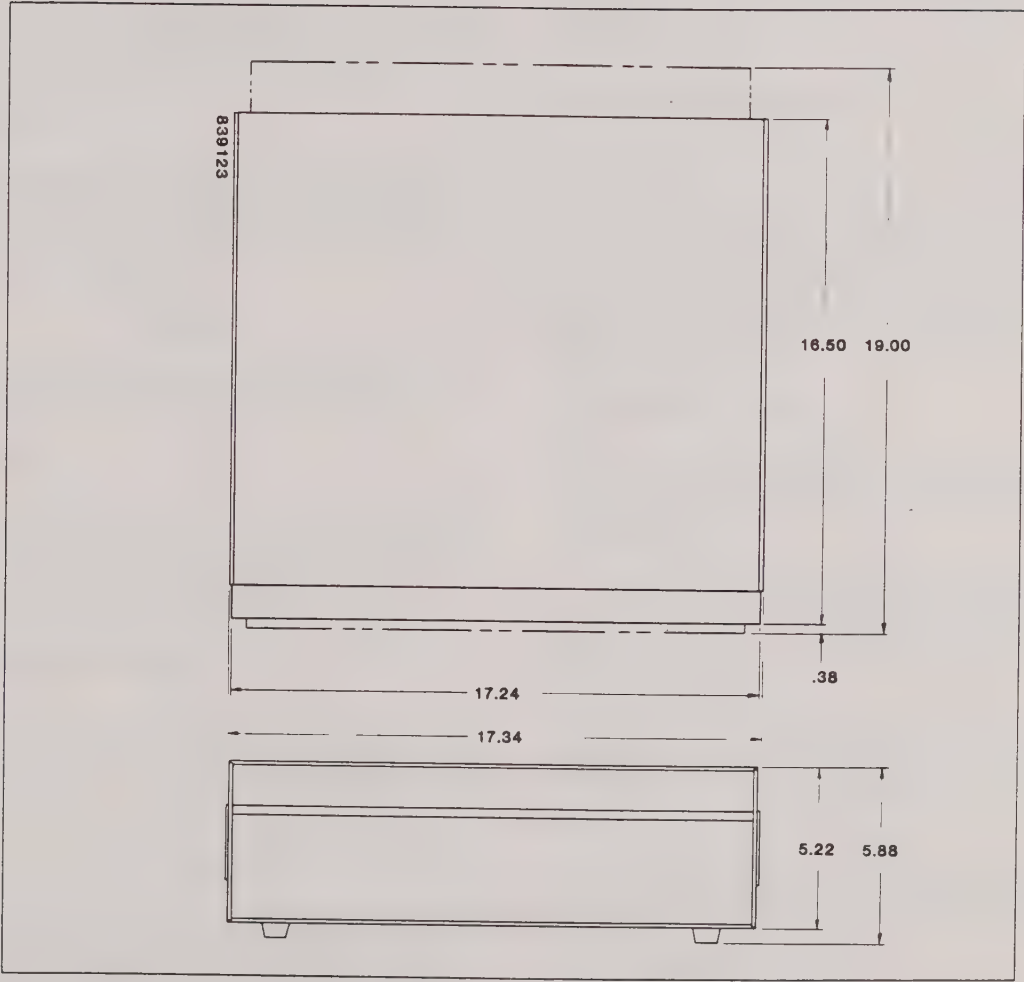


Figure 1-1. Outline Dimensions.

SECTION II INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains the unpacking, mounting, power requirements, cable connections, and preliminary check-out instructions for the Model 1110 Audio Oscillator.

2-3. UNPACKING.

2-4. The instrument is shipped complete and is ready to use upon receipt. Unpack the instrument from its shipping container and inspect for damage that may have occurred during shipment. Refer to Figure 2-1.

NOTE

Save the packing material and container for possible use in reshipment of the instrument.

2-5. MOUNTING.

2-6. For bench mounting choose a clean, sturdy, uncluttered mounting surface. For rack mounting, an accessory kit is available which provides mounting ears. The rack mounting kit contains the required hardware and instructions.

2-7. POWER REQUIREMENTS.

2-8. The instrument has a tapped power transformer and two line voltage selection switches which permit operation from 100, 120, 220, or 240 volt $\pm 10\%$, 50 to 400 Hz, single phase AC power sources.

CAUTION

Always make certain that the line voltage selection switches are set to the correct positions corresponding to the voltage of the AC power source, and that a fuse of the correct rating is installed before connecting the instrument to any AC power source.

Line Voltage Select Chart

VAC $\pm 10\%$	100 120	220 240	50 to 400 Hz
Fuse	3/4 ATD	3/8 ATD	40 VA

2-9. Set the rear panel line voltage selector switches to the appropriate positions as indicated in the Line Voltage Select Chart and check that the line fuse is correct for the selected power source.

2-10. CABLE CONNECTIONS.

2-11. Front panel connector:

OUTPUT. Source output HIGH and LOW BNC type connectors and chassis ground allow connection to external devices and components. The Output impedance is indicated by the keys marked 50, 150 and 600 located above the connectors. The LOW terminal is connected to chassis ground in the non-floating mode.

2-12. Rear panel connectors:

SYNC. The SYNC BNC type output connector provides a TTL compatible output relative to the frequency of the source output sine wave.

X CLK. The X CLK BNC type input connector provides a means of connecting an external 10 MHz counter reference. The external reference is automatically selected when a TTL level signal is present.

X AXIS. The X AXIS BNC type output connector provides a 0 to 5 volt d. c. level relative to the sweep frequency or level in the sweep mode. The output impedance is 1000 ohms.

PEN. The PEN BNC type output connector provides a TTL compatible signal to control the pen of an external recorder.

2-13. PRELIMINARY CHECK.

2-14. The preliminary check verifies that the Model 1110 is operational and should be performed before the instrument is placed into use. To perform the preliminary check, set the front panel LINE switch to ON. Wait several seconds then depress the LCL/INIT key. The FREQUENCY display will contain the instrument firmware number and the other displays will contain dashes for a period of about two seconds. The FREQUENCY display will then contain 1000.00 kHz with the KYBD legend illuminated the LEVEL display will contain 0.00 mV and the BUS/PRGM display will contain 99. The initialize sequence executes the oscillator frequency self-

check and resets all functions and operating modes of the Model 1110 to the initialized values and conditions listed in Table 2-1. If a hardware fault is evident in the oscillator frequency generation circuits, an error code (30-35) will be displayed.

2-15. Program location 99 is a recall-only location which contains the initialize values. The operating conditions at the time the instrument power is interrupted are maintained in non-volatile memory and restored when power to the Model 1110 is resumed.

TABLE 2-1. INITIAL CONDITIONS.

Level Group:	Frequency Group:	Bus/Prgm Group:
Level function enabled Level set to 0.00 mV Level Terminated calculated at 0.00 mV Load set to 0.600 k ohms Relative reference set to 0.00 dB Level Step set to 0.00 mV Special functions 0, 10, 55, 63 and 80 are selected	KYBD legend illuminated Frequency function enabled Frequency set to 1000.00 Hz Frequency Step set to 0.00 Hz Start set to 20.000 Hz Stop set to 20.000 kHz Sweep mode disabled Output disabled Float Disabled	Address function is unchanged Program function is set to 99 Service-Request is cleared Bus status is unchanged

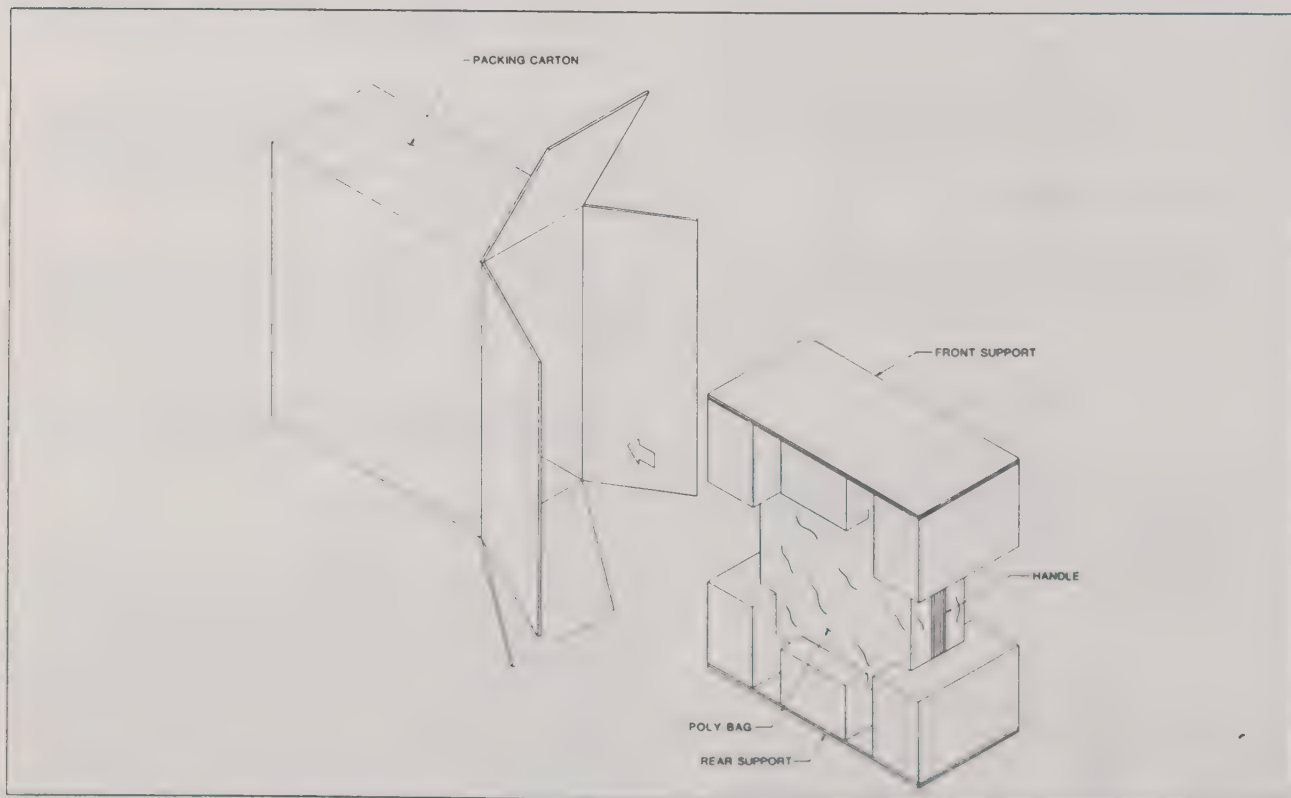


Figure 2-1. Packing and Unpacking Diagram.

SECTION III OPERATION

3-1. INTRODUCTION.

3-2. This section contains the operating instructions for the Model 1110 Audio Oscillator.

3-3. OPERATING CONTROLS, INDICATORS AND CONNECTIONS.

3-4. The controls, indicators and connectors used during the operation of the instrument are listed in Table 3-1 and shown in Figures 3-1 and 3-2.

3-5. OPERATING INSTRUCTIONS.

3-6. The operating instructions for the Model 1110 are divided into sections of Initial Conditions, Local Operation and Remote Operation.

3-7. INITIAL CONDITIONS.

3-8. Initialize the instrument as follows:

- a. Connect the power cord to the instrument and to the desired power source. Refer to paragraph 2-7 for proper power application.
- b. Set the front panel power switch to ON.
- c. Depress the LCL/INIT key.
- d. The FREQUENCY display will contain the instrument firmware identification number and the other displays will contain dashes for a period of about two seconds. After the initialization sequence is complete, the Model 1110 will be set to the conditions listed in Table 2-1.

3-9. LOCAL OPERATION.

3-10. **Function Selection.** The DATA ENTRY keypad is common to all functions of the Model 1110. The KYBD legend determines the active display window to which the DATA ENTRY keypad is dedicated at any given time. To select a function simply depress the function key desired. The results will be the LED of the function key will be illuminated, the current value of the selected function will be displayed in the window above the key, and the KYBD legend will be illuminated in the display window. The DATA ENTRY keypad is dedicated to the selected function and any unit

selection or number entry will appear in the active display window.

3-11. **Data Entry Operation.** Once a function has been selected, new values may be entered with the DATA ENTRY keypad. To enter data simply depress the desired digit keys followed by the appropriate unit key or ENTER key. During digit selection a (') mark will appear in the display to the left of the first digit selected to indicate the number in the display is in the process of being entered. No action is taken until the unit or ENTER key is depressed. The unit keys can also be used aside from number entry to select display modes. For example, to change the level displayed in mV to logarithmic units in dBV, simply select the LEVEL key and depress the dB key in the DATA ENTRY keypad. The display program will calculate and display the logarithmic value. The ENTER key serves a dual function as a dimensionless unit key for SPCL, ADRS, and PRGM number entry and also as a default unit terminator of V, Hz, and ohms for functions where more than one unit can be selected.

3-12. Many of the Model 1110 functions have multiple display and entry modes. Listed in table 3-2, Function Display And Data Entry Units, are the display legends which can be active for each function along with the unit keys in the DATA ENTRY keypad which select the available display modes. Argument entry ranges for all the Model 1110 functions are described in Table 3-3, Valid Function Argument Range. Number entry out of range of the selected functions will result in an error displayed in the FREQUENCY display window. Errors can be cleared by depressing any key. If at any time prior to entry a wrong digit is entered, depress the CLR key to clear and restore the previous display.

3-13. **Audio Oscillator General Description.** The Model 1110 contains a variable frequency, low distortion audio oscillator and a precision programmable amplifier/attenuator. The oscillator frequency tuning uses a frequency lock technique under microprocessor control to yield high accuracy and resolution. The output level can be varied in very fine increments over a wide range of levels. Levels can be set in either linear or logarithmic units to accommodate existing test procedures and applications. The oscillator incorporates a user configurable sweep mode which can be programmed to sweep frequency or level in logarithmic or linear increments.

3-14. **Oscillator Output Description.** The output configuration of the Model 1110 can be selected for single-ended

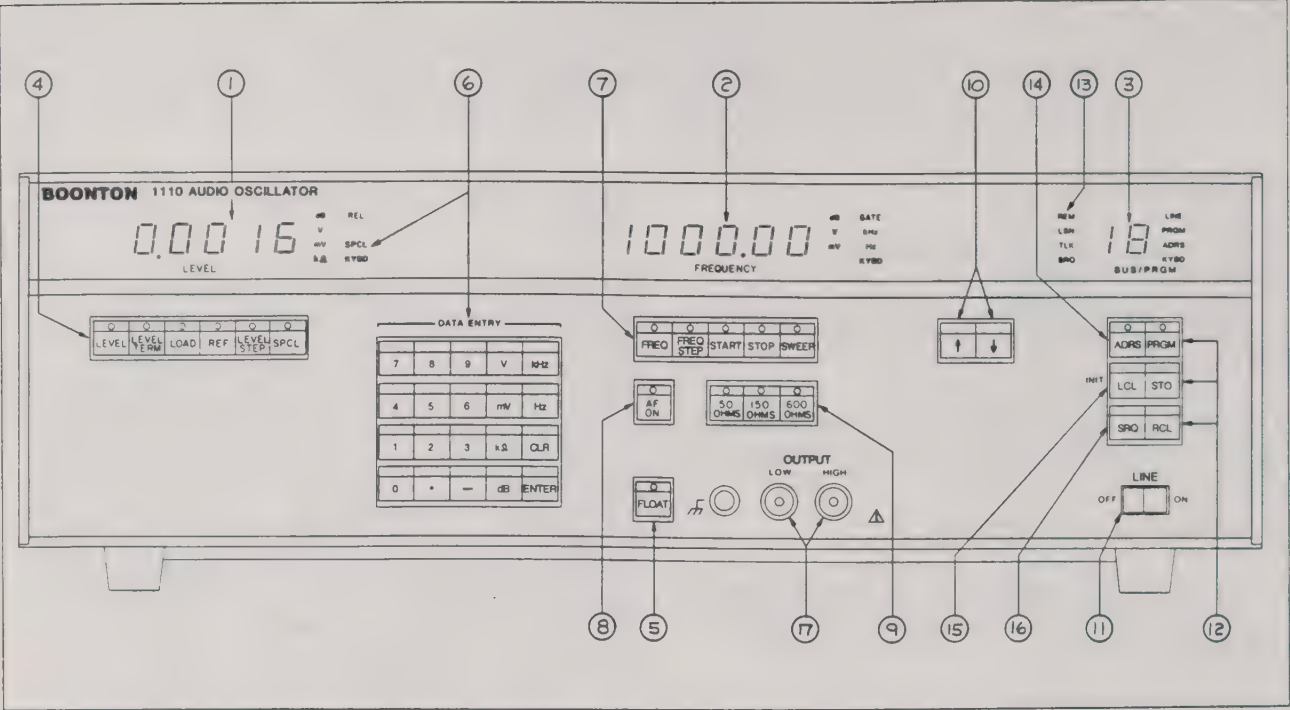


Figure 3-1. Model 1110, Front View.

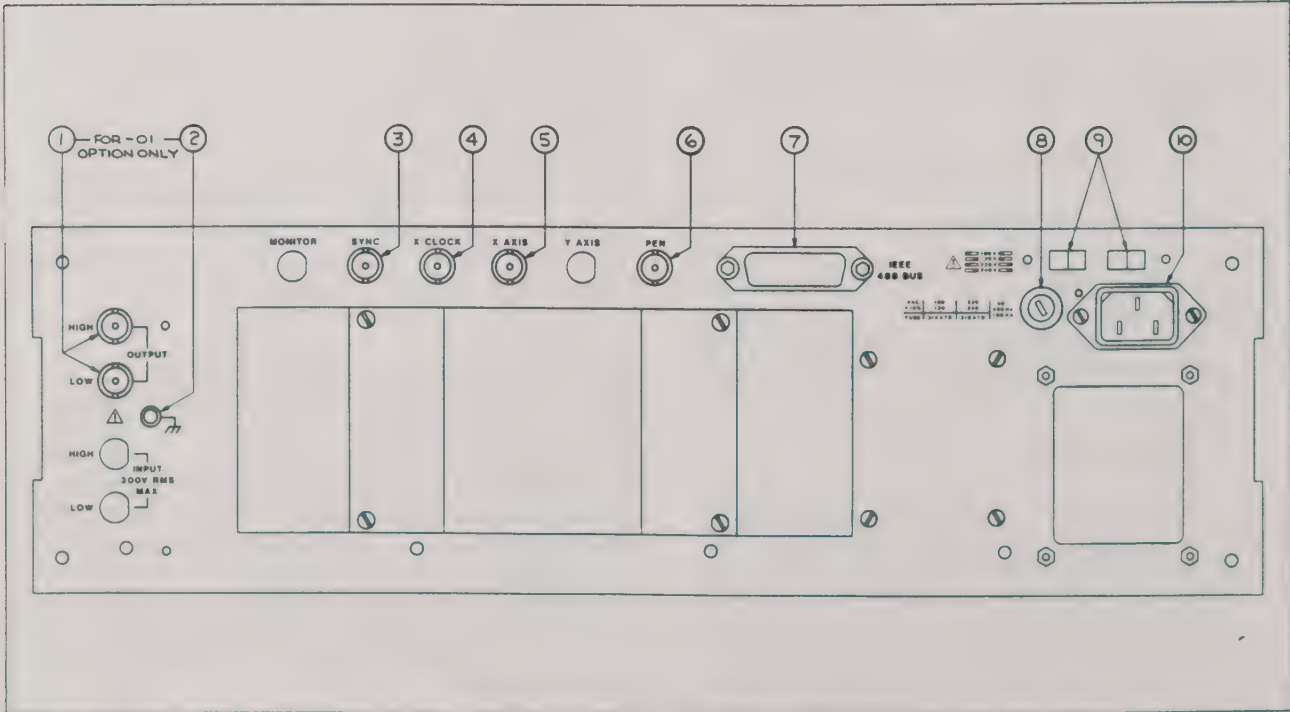


Figure 3-2. Model 1110, Rear View.

TABLE 3-1. CONTROLS, INDICATORS AND CONNECTORS.

Control, Indicator, or Connector	Figure and Index No.	Function
LEVEL display	3-1, 1	Displays open circuit level, terminated level, load impedance, relative reference value, level step size and special function code. (6 digit LED display)
FREQUENCY display	3-1, 2	Displays frequency value, sweep start value, sweep stop value, and frequency step size. Alternately displays error codes and messages. (8 digit LED display)
BUS/PRGM display	3-1, 3	Displays current program number or IEEE-488 bus address. (2 digit LED display)
LEVEL keys	3-1, 4	Selects the following active level functions.
LEVEL key		Displayed in mV, V, dBV or dBm
LEVEL TERM key		Displayed in mV, V, dBV or dBm
LOAD key		Displayed in k ohms
REF key		Displayed in dB
LEVEL STEP key		Displayed in mV, V or dB
SPCL key		Allows alteration to the normal analyzer modes of operation such as: frequency lock disable, range hold, sweep rate and resolution, and special modes for testing, troubleshooting.
FLOAT key	3-1, 5	Selects floating or single-ended output connection.
DATA ENTRY keypad	3-1, 6	Used with the function keys to enter data into the active display designated by the KYBD annunciator.
FREQUENCY keys	3-1, 7	Selects the following active frequency functions.
FREQ key		Displayed in Hz or kHz
SWEEP key		Initiates sweep mode and indicates sweep in progress
START key		Frequency values are displayed in Hz or kHz and level values are displayed in mV, V, dBV or dBm
STOP key		Frequency values are displayed in Hz or kHz and level values are displayed in mV, V, dBV or dBm
FREQ STEP key		Displayed in Hz or kHz

TABLE 3-1. CONTROLS, INDICATORS AND CONNECTORS CONTINUED.

Control, Indicator, or Connector	Figure and Index No.	Function
AF ON key	3-1, 8	Selects and deselects the output
Impedance keys	3-1, 9	Allows selection of the source output impedance.
Step keys	3-1, 10	Increments and decrements the active frequency or level value by the frequency step and level step sizes and single steps the program location function
LINE switch	3-1, 11	Switches the instrument AC power on or off.
PROGRAM keys	3-1, 12	Selects the following program functions.
PRGM key		Allows display and entry of the store/recall program location.
STO key		Stores the instrument setup at the current program location.
RCL key		Recalls the instrument setup at the current program location.
Bus status	3-1, 13	Displays the current IEEE-488 bus status; REM (remote enabled), LSN (listener addressed), TLK (talker active), and SRQ (service request).
ADRS key	3-1, 14	Allows display and entry of IEEE-488 bus address.
LCL/INIT key	3-1, 15	Causes the instrument to "go-to-local" when remote enabled otherwise executes the initialize sequence.
SRQ key	3-1, 16	Sets the IEEE-488 bus SRQ line true.
OUTPUT connectors	3-1, 17	LOW and HIGH. Used to apply the signal to external devices and components. The LOW terminal is connected to chassis ground in the non-floating mode.

or balanced/floating operation using the FLOAT key. The 50 OHMS, 150 OHMS and 600 OHMS keys select the source output impedance and the output can be enabled or squelched using the front panel AF ON key. When the output is squelched, the output attenuation is set to maximum while the source impedance and float configuration remain connected.

3-15. Frequency Display and Selection. To select the Frequency function simply depress the FREQ key. The key's LED and the KYBD legend will be illuminated and the FRE-

QUENCY display window will contain the current frequency setting. Once the function is selected a new frequency may be entered using the DATA ENTRY keypad. Display units can be selected by depressing either the Hz or kHz keys.

3-16. Frequency Lock Mode Description. The Model 1110 Audio Oscillator achieves high frequency accuracy and resolution through the use of a frequency lock technique. The design of the Model 1110 enables internal measurement of the oscillator frequency. During initialization after power is applied or when the LCL/INIT key is depressed, the oscil-

TABLE 3-1. CONTROLS, INDICATORS AND CONNECTORS CONTINUED.

Control, Indicator, or Connector	Figure and Index No.	Function
OUTPUT connectors	3-2, 1	Rear panel output connectors which replace the front panel input connectors.
Ground connector.	3-2, 2	Chassis ground connector.
SYNC connector	3-2, 3	Provides a TTL compatible output relative to the frequency of the sine wave output.
X CLK connector	3-2, 4	Provides a TTL compatible input for an external 10 MHz timebase reference. Automatic switching to external reference when present.
X AXIS connector	3-2, 5	Provides a 0 to 5 volt d. c. level in the sweep mode to control the X axis of an external recorder.
PEN connector	3-2, 6	Provides a TTL compatible output to control the pen of an external recorder.
IEEE-488 connector	3-2, 7	Provides a means for connecting the standard IEEE-488 bus interface cable.
Fuse holder	3-2, 8	AC line fuse holder.
Line voltage selector switches	3-2, 9	Selects the desired operating voltage.
AC connector	3-2, 10	AC power connector.

lator is sequenced through its five frequency bands and specific frequencies settings are verified for accuracy. Tuning errors are stored by the control program in internal memory as calibration factors. If the oscillator fails to function on any of the frequency bands, an error (30-34) will be displayed as an indication of a hardware fault requiring service.

3-17. When a frequency setting is entered the oscillator is coarse tuned to the setting by the control program. Thereafter, the internal frequency of the oscillator is measured and fine adjustments are made by the control program to tune the oscillator to within tolerance. Special function 16 disables the frequency lock mode to enable faster frequency settability and sweep rates where the full frequency accuracy of the oscillator is not required.

3-18. Level Display And Selection. To select the Level function simply depress the LEVEL key. The key's LED and the KYBD legend will be illuminated and the LEVEL display window will contain the current level setting. Once the function is selected a new level may be entered using the DATA ENTRY keypad. The level function allows display and selection of the open-circuit output level. When a level is selected, the programmable amplifier/attenuator is configured by the microprocessor circuits to one of the ranges listed in Table 3-4. Special function 18 disables the automatic range selection and holds the range that is active at the time the special function is enabled. When the range-hold mode is active, new levels may be entered from 0 V up to the maximum value for the selected range. This mode provides the ability to generate levels over a wide dynamic range without the delay and transients associated with range to range tran-

sitions. The LEVEL function can be incremented or decremented by the value in the LEVEL STEP function and can also be displayed as a relative value using the REF function.

3-19. Terminated Level Display and Selection. To select the Terminated Level function simply depress the LEVEL TERM key. The key's LED and the KYBD legend will be illuminated and the LEVEL display window will contain the current level setting. Once the function is selected a new level may be entered using the DATA ENTRY keypad. The LEVEL TERM function operates the same as the LEVEL function except that the value entered and displayed in mV, V or dBV units is the amplitude at the load instead of the open-circuit amplitude. The value is calculated based on the open-circuit amplitude and the source and load impedances. Alternate selection of the AF ON, 50 OHMS, 150 OHMS, or 600 OHMS keys will update the displayed value to the extent that the terminated voltage is changed. The LEVEL TERM function can be incremented or decremented by the value in the LEVEL STEP function and can also be displayed as a relative value using the REF function.

3-20. Load Display and Selection. To select the Load function simply depress the LOAD key. The key's LED and the KYBD legend will be illuminated and the LEVEL display window will contain the current load impedance setting. Once the function is selected a new value may be entered using the DATA ENTRY keypad. The LOAD function enables the entry of the external load impedance used to calculate the LEVEL TERM value. Refer to paragraph 3-19. The load value may only be displayed in k ohm units but may be entered with the DATA ENTRY keypad in k ohms or ohms using the respective k ohm or ENTER keys.

3-21. Reference Display and Selection. Amplitude values for the LEVEL, LEVEL TERM, START and STOP functions may be displayed as relative values. In some applications external amplifiers or attenuators may be required to provide signal levels outside the operating range of the Audio Oscillator. The reference mode scales the display of the Model 1110 to account for the change in signal level. Entering a value other than 0.00 dB in the REF function enables the reference mode. The REL annunciator remains

TABLE 3-2. FUNCTION DISPLAY AND DATA ENTRY UNITS.

Function	Display Legends	Unit Keys	Default Units (ENTER Key)
LEVEL GROUP:			
LEVEL	mV V dBV dBm	mV V dB	V
LEVEL TERM	mV V dBV dBm	mV V dB	V
LOAD	k ohms	k ohms	ohms
REF	dB	dB	dB
SPCL	SPCL	ENTER	dimensionless
FREQUENCY GROUP:			
FREQ	Hz kHz	Hz kHz	Hz
START	Hz kHz mV V dBV dBm	Hz kHz mV V dB	Hz
STOP	Hz kHz mV V dBV dBm	Hz kHz mV V dB	Hz
FREQ STEP	Hz kHz	Hz kHz	Hz
BUS/PRGM GROUP:			
ADRS	ADRS	ENTER	dimensionless
PRGM	PRGM	ENTER	dimensionless

illuminated when amplitudes are displayed indicating the value displayed is relative. Entering 0.00 dB as a reference extinguishes the annunciator and returns the display to normal.

3-22. Amplitude Display Units. Amplitude values for the LEVEL, LEVEL TERM, START and STOP functions may be displayed in linear units of mV or V or as a logarithmic value in units of dBV or dBm. Display units can be selected

by depressing either the mV, V, or dB keys. Special functions 80 through 86 and 89 select the logarithmic display mode where 80, dBV, is the default selection. The dBV display mode converts the linear voltage display (open-circuit or terminated) to a logarithmic value relative to 1.000 V rms. When a dBm mode is selected, the actual power into the load is calculated and displayed based on the open-circuit level and source and load impedance settings.

TABLE 3-3. VALID FUNCTION ARGUMENT RANGE.

Function	Argument Range	Entry Action	Error No.
LEVEL GROUP:			
LEVEL ¹	0 mV to 16 V -120 to 24.08 dBV	Open circuit output level (lin) Open circuit output level (log)	03 03
LEVEL TERM ^{1,2}	variable	Terminated output level	13
LOAD	0.1 ohm to 1000 k ohms	Load termination value	14
REF	-40 to 40 dB	Relative reference	15
LEVEL STEP	0 mV to 16 V 0 to 120 dB	level increment (lin) level increment (log)	04 04
SPCL	See TABLE 3-5	See TABLE 3-5	05
FREQUENCY GROUP:			
FREQ	10 Hz to 150 kHz	Source Frequency	01
START ¹	10 Hz to 150 kHz 0 mV to 16 V -120 to 24.08 dBV	Sweep start frequency Sweep start level (lin) Sweep start level (log)	06 06 06
STOP ¹	10 Hz to 150 kHz 0 mV to 16 V -120 to 24.08 dBV	Sweep stop frequency Sweep stop level (lin) Sweep stop level (log)	07 07 07
FREQ STEP	0 Hz to 150 kHz	Frequency increment	02
BUS/PRGM GROUP:			
ADRS	0 to 30	IEEE-488 Bus Address	10
PRGM	0 to 99	Store/Recall Location	11

NOTE 1 Amplitude values can be entered and displayed in dBm units and/or as relative values. The allowable argument range for dBm values varies based on the source and load impedance settings and is limited by the open-circuit voltage range. The allowable argument range for relative values varies based on the REF function value.

NOTE 2 Allowable argument range for Terminated Level values varies based on source and load impedance settings and is limited by the open-circuit voltage range.

3-23. Step Size and Step Key Operation. The keys used with up and down arrows are used to increment and decrement function values in the active window designated by the KYBD legend. If an arrow key is constantly depressed, the stepping will repeat. Functions which can be stepped are PRGM, FREQ, START, STOP, LEVEL, and LEVEL TERM. Stepping any other function has no effect.

3-24. Increment/Decrement Program Number. The Program number can be stepped in single increments. A special Auto-recall function is provided which automatically executes the recall operation after the program location function has been incremented or decremented with the step keys. This function allows rapid recall of sequential program setups by using a single key or bus mnemonic. The auto-recall function can be enabled or disabled using the internal option switch A4S1-5 or special functions 7 and 8.

3-25. Increment/Decrement Frequency Values. Frequency values in the FREQ, START, and STOP functions can be stepped by the value in the FREQ STEP function. Available Frequency step sizes are listed in Table 3-3. The Frequency step size also functions as the step size for the linear frequency sweep mode.

3-26. Increment/Decrement Level Values. Amplitude values in the LEVEL, LEVEL TERM, START, and STOP functions can be stepped by the value in the LEVEL STEP function. Level step sizes can be linear or logarithmic values. Available Level step sizes are listed in Table 3-3. The Level step size also functions as the step size for the linear and logarithmic level sweep modes.

3-27. Sweep Mode General Description. The Model 1110 provides a user programmable sweep capability which simplifies time consuming measurements such as flatness, gain and compression/expansion linearity. In the sweep mode the Model 1110 is used as the stimulus and can be configured to sweep frequency or level in linear or logarithmic steps. The Model 1110 provides the X axis and pen control signals for an external plotter/recorder.

3-28. SWEEP Key Description. The SWEEP key is an alternate action key which initiates and terminates the sweep. The key's LED indicates a sweep is in progress and will be illuminated for the period of one sweep.

3-29. START Key Description. The START key allows entry of either the frequency or level start value. The start value defines the origin of the X axis which corresponds to 0 volts at the X AXIS output connector. When the START key is depressed the FREQUENCY display will contain the start value and 0 volts is presented at the X AXIS output connector as an aid in setting the offset adjustment on most X-Y plotters. The start value can be either a frequency, open-circuit

level or a relative level.

3-30. STOP Key Description. The STOP key allows entry of either the frequency or level stop value. The stop value defines the end of the X axis which corresponds to 5 volts at the X AXIS output connector. When the STOP key is depressed the FREQUENCY display will contain the stop value and 5 volts is presented at the X AXIS output connector as an aid in setting the sensitivity adjustment on most X-Y plotters. The stop value can be either a frequency, open-circuit level or a relative level.

3-31. X AXIS Output Description. The X AXIS output of the Model 1110 is the scaled result of the sweep frequency or level relative to the start and stop values. The Model 1110 can be swept in level or frequency with 4096 points of resolution on the X axis. Selection of a level or frequency sweep is determined by the type of start and stop values entered: start and stop level entries designate a level sweep and start and stop frequency entries designate a frequency sweep.

3-32. PEN Output Description. The Model 1110 generates a TTL compatible pen control output for use with a plotter/recorder. The active state of the PEN output is selected using option switch A4S1-3 or special functions 5 and 6.

3-33. Using The Sweep Mode. When the SWEEP key is depressed the start value is transferred to the LEVEL or FREQ function, and the function is activated. When the sweep is in progress the X AXIS output will produce an incrementing voltage between 0 and 5 volts. The start and stop values must be compatible in level or frequency units or an error will be displayed when the SWEEP key is depressed. When the sweep sequence is initiated the X axis information is presented at the rear panel X AXIS output and after an approximate 1 sec delay the PEN output is set true. When the sweep is terminated the PEN output is immediately set false. The PEN output can be set independent of any sweep operation using the PU and PD bus mnemonics.

3-34. The sweep mode will be terminated if any number entry is attempted, any function is selected other than the functions displayed at the start of the sweep sequence, or either the SWEEP key or the LCL/INIT key is depressed. Selecting source impedance, floating mode, and display units will not terminate the sweep mode. If a sweep has been terminated, it can be resumed by selecting the appropriate LEVEL or FREQ function and depressing the SWEEP key. The sweep will be activated and will resume from the displayed value until the stop value is reached.

3-35. Generating Frequency Sweeps. The Model 1110 can generate user configurable frequency sweep sequences up to the entire frequency range of the oscillator in logarithmic

TABLE 3-4. OUTPUT LEVEL RANGES.

Level Ranges:	Resolution:
16.000 to 3.005 V	5.0 mV
3.000 to 0.301 V	1.0 mV
300.0 to 30.1 mV	0.1 mV
30.00 to 0.00 mV	0.01 mV

mic or linear increments. The range of the sweep is defined by the start and stop values which can be in ascending or descending order. Logarithmic frequency increments are selected using special function 51 through 59 and vary from 16 to 4096 steps. Linear frequency increments are selected using special function 50 and the FREQ STEP function defines the increment value. Linear sweep step sizes which exceed the X axis resolution limit of 4096 steps are allowed, however, the X AXIS output voltage will dwell at the same level for more than one frequency increment.

3-36. Generating Level Sweeps. The Model 1110 can generate user configurable level sweep sequences up to the entire level range of the oscillator in logarithmic or linear increments. The range of the sweep is defined by the start and stop values which can be in ascending or descending order. Logarithmic and linear level increments are selected using the LEVEL STEP function. Special functions 50 through 59 have no effect on level sweep. A logarithmic level sweep is defined by a level step value expressed in dB units and a linear level sweep is defined by a level step value expressed in mV or V units. Level sweep step sizes which exceed the X axis resolution limit of 4096 steps are allowed, however, the X AXIS output voltage will dwell at the same level for more than one level increment.

3-37. Program Store And Recall Description. The entire status of the Model 1110, including all functions, entered values and display modes, can be saved in a program location of non-volatile memory for recall at a later time. Up to 99 such programs (0-98) can be stored and recalled.

3-38. Store Operation. To save the complete front-panel setup in the program memory, first set all the desired instrument operating parameters to be stored. Next depress the PRGM key and enter the desired program location with the DATA ENTRY keypad and the ENTER key. Finally, depress the STO key to save the complete instrument status in program memory. Below is a list of all the parameters which are retained in program memory.

1. All entered values of all functions.
2. All source impedance and floating settings.
3. All display modes and selected display units.
4. All special functions settings

3-39. Recall Operation. To recall the front-panel setup in the program memory, depress the PRGM key and enter the desired program location with the DATA ENTRY keypad and the ENTER key. After the memory location has been selected, depress the RCL key. Program location 99 is a recall-only location that restores the initialize parameters in the same manner as the LCL/INIT key. Any panel setting may be changed after recalling a program location.

3-40. Program Memory Initialization. In normal use the internal memory is never erased, new programs are simply written over the old ones. It is necessary, however, to erase the program memory after a new firmware revision has been installed or after the CPU circuit board has been serviced. Entering special function 25 will erase the entire program memory. Attempting to recall an erased program will result in Error 11 being displayed. Special function 25 can be disabled using the internal option switch A4S1-4.

3-41. Special Function Description. The Model 1110 provides special modes of operation for specific application situations. Special function modes shown in Table 3-5 can be selected using the SPCL key and the DATA ENTRY keypad.

3-42. Option Switch Functions. Codes 1 through 8 supersede current settings of the internal Option switch, A4S1. The option switch settings are restored on power-up, by executing special function 0, or by depressing the LCL/INIT key.

3-43. Mode Alteration Functions. Codes 16 and 18 alter the normal operation of the Model 1110. When selected, the SPCL legend in the LEVEL display window will remain illuminated as an indication of the special operating mode regardless of the function displayed.

3-44. The unlock frequency function, 16, is provided to speed repetitive frequency setting. In normal operation a variable period of 20 to 200 mS is required to measure the actual oscillator frequency, calculate the frequency deviation and apply fine tune correction. Inhibiting the frequency lock operation results in faster frequency settability at the cost of frequency accuracy. The unlock mode is cleared by entering special function 10 or initializing the instrument.

3-45. The range-hold function, 18, is provided to hold specific output level ranges. Available level ranges and

resolution are listed in Table 3-4. Range-hold mode is cleared by entering special function 10 or initializing the instrument.

3-46. Initialization And Test Functions. Codes 25, 30 and 31 are used for memory initialization, testing and troubleshooting of the Model 1110. These functions can be disabled using Option switch A4S1-4 to prevent accidental use resulting in possible loss of current memory data.

3-47. Frequency Sweep Resolution Functions. Codes 50 through 59 allow selection of linear or logarithmic frequency sweep modes and logarithmic sweep resolution. The default mode after initialization is code 55.

3-48. Sweep Rate Functions. Codes 60 through 69 allow selection of the time delay for each sweep step. The delay may be selected in 500 mS increments from 0 to 4.5 seconds. The default mode after initialization is code 63.

3-49. Source Impedance Selection Functions. Codes 75 through 77 are used as an alternate mode for selection of the source output impedance. These functions perform the same action as the front panel 50 OHMS, 150 OHMS and 600 OHMS keys. The default mode after initialization is 600 ohms, code 77.

3-50. dBV/dBm Display Mode Functions. Codes 80 through 86 and 89 are used to select the reference used to calculate the logarithmic display value (dBV or dBm). All logarithmic levels will be displayed in the form selected. When any of codes 81 through 86 are selected, the the LOAD function value will automatically be set to the respective load impedance. Code 89, however, calculates the dBm reference (1mW) relative to the current LOAD function value. Code 80 has no effect on the LOAD function value. The default mode after initialization is dBV, code 80.

3-51. Option Switch, A4S1, Operation. Several of the Model 1110 operating features are internally programmable by setting bit switch A4S1. Gaining access to the switch requires that the cover be removed. Some of the option switch functions can be altered using the special functions 1 through 8. The option switch consists of eight separate switches which change the operating conditions of the Model 1110. Table 3-6 list the individual switches and their function.

3-52. Positions 1 and 2 of A4S1 are used for end-of-string (EOS) control for the IEEE-488 bus. End-or-Identify (EOI) is always recognized and asserted in addition to the EOS characters selected. Position 3 determines the pen-up active state of the PEN output on the rear panel. Position 4 is available to restrict the use of special functions 25, 30 and 31. These special functions are associated with initialization and repair of the instrument. Position 5 determines the operation of the IEEE-488 SRQ function. When enabled the SRQ line

will be set true if the SRQ key is depressed or if the instrument is in the remote condition and an error is generated. Position 6 determines the auto-recall function. Normally the REC key must be depressed in order to recall any program location. When enabled the auto-recall function automatically performs the REC function when using the step keys to increment or decrement the PRGM function. However, entering a program location directly using the DATA ENTRY keypad requires that the REC key be depressed to execute the recall function. Positions 7 and 8 are used for test modes. When the lamp test is selected the display LEDs, display legends, and key LEDs with the exception of the LEVEL and FREQUENCY function keys will be constantly illuminated. The remaining function keys will be illuminated in sequence.

3-53. Error Codes. Error codes and descriptions for the Model 1110 are listed in Table 3-7. The error codes will appear in the FREQUENCY display window and will be returned by the talk-status (TS) IEEE-488 bus function if executed. The SRQ status byte will consist of the error code expressed in excess sixty-four. The status code 64 decimal means the SRQ was activated by the front panel SRQ key rather than an error.

3-54. REMOTE OPERATION.

3-55. Any front-panel operation of the instrument with the exception of the POWER ON/OFF switch and the ADRS function can be remotely controlled under direction of an IEEE-488 interface controller.

3-56. Setting the Bus Address. To set the IEEE-488 bus address (MLTA), depress the ADRS key, enter the address number by means of the DATA ENTRY keypad and use the ENTER key to complete the entry. The address may be any decimal number from 0 to 30, inclusive. A secondary address is not implemented.

3-57. Entering the Remote Mode. The instrument is put in the remote mode by addressing it as a listener with remote enable (REN) true. In the remote state the keyboard is disabled, except for the LCL/INIT key and the POWER ON/OFF switch, and the REM status annunciator is illuminated.

3-58. Returning to Local Mode. The instrument may be returned to the local mode as follows:

- a. The LCL/INIT key is depressed, provided local lockout (LLO) is not active.
- b. The go-to-local (GTL) bus command is sent.
- c. Remote enable (REN) is set false.

TABLE 3-5. SPECIAL FUNCTIONS.

Option Switch A4S1 Functions:			
0	Restores settings of internal option switch		
	<u>Listen:</u>	<u>Talk:</u>	
1	EOS Character: LF or CR LF	CR LF	
2	EOS Character: CR	CR LF	
3	EOS Character: CR	CR	
4	EOS Character: CR	CR	
5	Pen-up is active high		
6	Pen-up is active low		
7	Disable program auto-recall		
8	Enable program auto-recall		
Mode Alteration Functions:			
10	Clear functions 16 and 18		
16	Unlock frequency		
18	Hold output level range		
Initialization And Test Functions:			
	(These functions can be disabled using option switch A4S1-4)		
25	Erase all program memory locations		
30	Dac test mode		
31	Counter plug-in board test mode		
Frequency Sweep Resolution Functions:			
50	Linear frequency sweep (frequency step value determines resolution)		
51	16 step logarithmic sweep		
52	32 step logarithmic sweep		
53	64 step logarithmic sweep		
54	128 step logarithmic sweep		
		55	256 step logarithmic sweep
		56	512 step logarithmic sweep
		57	1024 step logarithmic sweep
		58	2048 step logarithmic sweep
		59	4096 step logarithmic sweep
		Sweep Rate Functions:	
		60	Rapid Sweep
		61	0.5 Sec/step
		62	1.0 Sec/step
		63	1.5 Sec/step
		64	2.0 Sec/step
		65	2.5 Sec/step
		66	3.0 Sec/step
		67	3.5 Sec/step
		68	4.0 Sec/step
		69	4.5 Sec/step
		Source Output Impedance Selection Functions:	
		75	50 ohm output impedance
		76	150 ohm output impedance
		77	600 ohm output impedance
		dBV/dBm Display Mode Selection Functions:	
		80	dBV display reference: 1.000 V
		81	dBm display reference: 1 mW, 50 ohms
		82	dBm display reference: 1 mW, 75 ohms
		83	dBm display reference: 1 mW, 150 ohms
		84	dBm display reference: 1 mW, 300 ohms
		85	dBm display reference: 1 mW, 600 ohms
		86	dBm display reference: 1 mW, 900 ohms
		89	dBm display reference: 1 mW into the impedance specified by LOAD function

NOTE

The instrument must be placed in the remote mode for it to store and respond to data messages.

3-59. Triggered Operation. In the remote mode the instrument can be operated in the immediate mode (mnemonic IM), or in the wait-for-trigger mode (WT). The immediate mode is the default condition and results in the immediate response to mnemonic commands and settings. The wait-for-trigger mode causes the execution of commands and settings to be deferred until a trigger is received. This aids in synchronizing the instrument's state changes to other system components. The wait-for-trigger mode is set when the WT

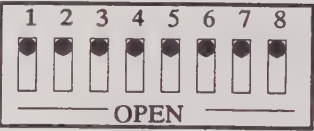
mnemonic is encountered in the input string. From that point on execution is delayed. No change will occur until one of the following events is encountered:

- "Group-execute-trigger" (GET) is received.
- The mnemonic TR (trigger) is interpreted.
- Any mnemonic following IM (immediate) is interpreted.

NOTE

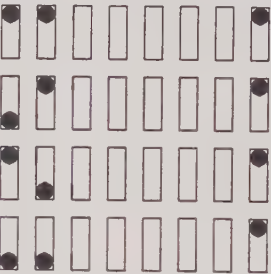
Event (c), above, or go-to-local terminates the wait-

TABLE 3-6. OPTION SWITCH A4S1.



Factory settings.

EOS Character Selection:



Listen: LF or CR LF

Talk: CR LF



Listen: CR

Talk: CR LF



Listen: CR

Talk: CR



Listen: CR

Talk: LF

Pen Status Control:



Pen-up is active low



Pen-up is active high

SPCL Function Disable:



Enable SPCL Functions 25, 30 and 31



Disable SPCL Functions 25, 30 and 31

Auto Recall Enable:



Disable Program Auto-recall



Enable Program Auto-recall

SRQ Enable:



Disable SRQ



Enable SRQ

Test Mode Enable:



Lamp Test



Reference Test

TABLE 3-7. ERROR CODES.

Error Code	Description
01	Illegal source frequency entry
02	Illegal frequency step size entry
03	Illegal source level entry
04	Illegal level step size entry
05	Illegal special function entry
06	Illegal start frequency or level entry
07	Illegal stop frequency or level entry
10	Bus address entry out of range
11	Store/Recall error: attempting to recall an erased location or Store in read-only location No. 99
13	Illegal level terminated entry
14	Illegal load entry
15	Illegal reference entry
20	Illegal units for active function
21	Buffer overflow: too many key entries for display or IEEE-488 buffer overflow
22	IEEE-488 bus error: non existent mnemonic
23	IEEE-488 bus error: illegal Learn string format
24	IEEE-488 bus error: illegal Burst string format
25	Sweep error: Start and stop units are not compatible
26	Sweep error: Start and stop values are equal.
30-35	Hardware error: Frequency lock

*for-trigger mode and restores the immediate mode.
The wait-for-trigger mode is not active in local operation.*

3-60. Talk Operation. The instrument may be addressed as a talker without regard for remote/local mode. When the talker state is set by the bus controller, the instrument sends a character string which is determined by the current talk mode. One of six different talk modes is selected by sending the appropriate mnemonic with the Model 1110 addressed as a listener. The selected mode will remain in effect until changed.

3-61. Talk Status (TS) Mode. In the TS mode the error code status of the instrument is returned as a number. Normal status returns a 0 code otherwise the error number is returned. The TS mode will automatically clear the error after the status is reported. The TS mode is the default talk mode after initialization of the instrument.

3-62. Talk Value (TV) Mode. In the TV mode The argument of the active function designated by the KYBD annun-

ciator is returned as a number. All values returned are in basic units such as: Hz, V, ohms, dB, etc.

3-63. Talk Program (TP) Mode. In the TP mode a 6 digit number is returned that uniquely identifies the firmware.

3-64. Talk Function (TF) Mode. In the TF mode a variable length string of ASCII characters will be returned which identifies the state of all active functions. The bit assignments are arranged to allow for string or byte oriented decoding. The various characters are listed in Table 3-9.

3-65. Talk Learn (TL) Mode. In the TL mode a compressed parameter string of 143 ASCII characters, the last of which is an ASCII (\$), is returned. This string can be sent back to the instrument at any time to restore the exact state of all functions and settings which defined it, but it must be sent as a complete string without alteration. When the (\$) character is encountered in the input buffer, the learn mode is automatically activated. While this form provides a compact and fast method to save and restore all settings, it bypasses much of the error control and must be used with caution.

3-66. Talk Burst (TB) Mode. In the TB mode a compressed parameter string of 21 ASCII characters, the last of which is an ASCII (&), is returned. Like the Learn string, this string can be sent back to the instrument at any time to restore the exact state of the level and frequency settings which defined it, but it must be sent as a complete string without alteration. While this form provides a compact and fast method to save and restore frequency and amplitude setting to create sweep or tone burst sequences, it bypasses update of the display and much of the error control and must be used with caution. To prevent the display from giving false indications the display may be blanked using the (BL) command.

3-67. End-Of-String (EOS) Control. The instrument provides several end-of-string options to accommodate a wide variety of controllers. The instrument always terminates on EOI (end-or-identify) true and always sends EOI true with the last character of every string. In addition, CR, LF, or CRLF may be used. The use of CR and LF is selected by option switch A4S1-1 and 2 and special functions 1 through 4. Detection of EOI is not affected by A4S1 switch settings.

3-68. Using "Service Request" (SRQ). The instrument may be configured to set SRQ true when it is in the remote mode and an error occurs. This is enabled by setting the op-

TABLE 3-8. IEEE-488 BUS MNEMONICS.

Level Function Group:		Source Output Group:	
SL	Source Level	ON	Enable AF output
LT	Level terminated	OF	Disable AF output
LD	Load	Z0	50 ohm output impedance
RF	Reference	Z1	150 ohm output impedance
LZ	Level step size	Z2	600 ohm output impedance
SP	Special function	SS	Single-ended source output
		FS	Floating source output
Frequency Function Group:		Talk Mode Group:	
SF	Source Frequency	TS	Talk status
XL	Start	TV	Talk value
XR	Stop	TF	Talk function
FZ	Frequency step size	TL	Talk learn string
		TB	Talk burst string
		TP	Talk program revision
Program Function Group:		Trigger Group:	
PG	Program location	IM	Immediate mode
RE	Recall program	WT	Wait-for-trigger mode
ST	Store program	TR	Trigger
Sweep Control Group:		Display Mode Group:	
SW	Sweep mode	BL	Blank display
SG	Signal generator mode	UD	Update display
PU	Pen-up		
PD	Pen-down		
Units Group:		Error and SRQ Group:	
HZ	Hertz	CL	Clear error
KH	Kilohertz	EI	Enable SRQ interrupt
VO	Volt	DI	Disable SRQ interrupt
MV	Millivolt		
KO	Kilohm		
DB	Decibel		

TABLE 3-9. TALK FUNCTION (TF) DECODING.

Talk Function String Format:**99,999,AAAAAAAAAAAAAAAA****Active Function Assignments:**

- | | |
|----|------------|
| 1 | FREQ |
| 2 | FREQ STEP |
| 3 | LEVEL |
| 4 | LEVEL STEP |
| 5 | SPCL |
| 6 | START |
| 7 | STOP |
| 10 | ADRS |
| 11 | PRGM |
| 13 | LEVEL TERM |
| 14 | LOAD |
| 15 | REF |

Option Switch Bit Assignments:

- | | |
|--------|--|
| [8]MSB | A4S1-8 Lamp Test |
| [7] | A4S1-7 Reserved |
| [6] | A4S1-6 Enable SRQ |
| [5] | A4S1-5 Enable program auto-recall |
| [4] | A4S1-1 End-of-String Character Select |
| [3] | A4S1-2 End-of-String Character Select |
| [2] | A4S1-3 Pen-up active high |
| [1]LSB | A4S1-4 Disable Special Functions 25 and 30 |

Alternate Operating Modes:

- | | |
|----|----------------------------|
| Z0 | 50 ohm output impedance |
| Z1 | 150 ohm output impedance |
| Z2 | 600 ohm output impedance |
| ON | AF output enabled |
| FS | Float source |
| SW | Sweep mode |
| XC | External counter reference |
| UL | Unlock frequency mode |
| RH | Range hold mode |

tion switch A4S1-6 to the open position. The bus controller must be programmed to respond to SRQ true. In the usual case, the controller then executes a serial poll to determine which device caused SRQ to be true. If the instrument is the requesting device, it will respond to the serial poll with a single byte which expresses the error code number in excess sixty-four. The serial poll will clear the SRQ line automatically. In small systems only one instrument may be capable of using SRQ. In this situation there is no need to execute a serial poll since the identity of the requesting device is known. The

error code may be obtained directly from the talk status (TS) mode. The SRQ line can then be cleared by sending the clear (CL) command.

3-69. Bus Command Responses. IEEE-488 bus commands are sent by the controller to all devices on the bus (Universal Command Group) or to addressed devices only (Addressed Command Group). The response of the instrument is listed in Table 3-10.

TABLE 3-10. BUS COMMAND RESPONSES.

Commands	Instrument Response
Universal Command Group: Device Clear (DCL) Local Lockout (LLO) Serial Poll Enable (SPE) Serial Poll Disable (SPD)	Clear errors Disable LCL/INIT key Sets talk mode for poll response Restores talk mode before poll
Addressed Command Group: Selective Device Clear (SDC) Go to Local (GTL) Group Execute Trigger (GET)	Same as device clear (DCL) Sets LOCAL mode Triggers a measurement
All Others:	Ignored

3-70. Program Function Mnemonics. Each front panel key is assigned a program mnemonic. Programming the mnemonic, followed by unit values, if appropriate, is analogous to manual front-panel operation. In addition, other program mnemonics are used for functions that are applicable only in remote operation. Table 3-8 lists all the program function mnemonics.

3-71. Number Formatting. Number formatting rules are as follows:

- Fixed or floating formats are accepted.
- The optional + or - sign may precede the mantissa and/or the exponent.
- The optional radix point may appear at any position within the mantissa. A radix point in the exponent is ignored.
- The optional "E" for exponent may be upper or lower case.
- ASCII characters having hexadecimal values of 0 to 23 and 26 to 2C are ignored.

3-72. Data String Format. Data string formats are as follows:

- The programming sequence is in natural order, that is, a function mnemonic is sent first followed by the argument, if appropriate.
- ASCII characters having hexadecimal values of 0 to 23 and 26 to 2C are ignored. The ASCII (\$) and (&),

hexadecimal 24 and 25, are reserved. Lower case letters are automatically changed to upper case.

- A primary function mnemonic sent without a following argument will make the specified function active.
- The data string may not exceed 150 characters and may be terminated with LF, CR, and/or EOI.
- Interpretation of the data string does not begin until termination occurs.
- If units are unspecified for any argument, default units are automatically appended. The functions SPCL and PRGM always use default units.
- If a unit mnemonic is sent without a corresponding argument, the display will reflect the change provided that the units are appropriate for the active function and the display can accommodate the rescaled number.

3-73. Data String Errors. Errors are detected during interpretation. The occurrence of an error will display the error code if the display is enabled, and will set SRQ true, if enabled. The error and SRQ can be cleared by a serial poll, a status request (TS), or a clear error instruction (CL). All errors cause previous valid parameters to be restored. No new input can be processed until an existing error is cleared.

3-74. Data String Examples. The following are examples of typical programming strings in HP BASIC:

OUTPUT 715; "SP16SF1234.56HZ"

OUTPUT 715; "Z1FSSL2VO"

OUTPUT 715; "PG1RE"

OUTPUT 715; "LD.05KO"

3-75. Store and Recall Operation. Store and Recall operation may be used to advantage with a bus controller. The instrument provides either temporary or long-term

storage for control strings. This can be used to minimize bus traffic by storing several control setups at initialization and recalling them when needed with a simple string statements, such as:

OUTPUT 715; "PG23RE"

Since few controllers have power fail protection, the data in the instrument's non-volatile memory is the more secure.

SECTION V MAINTENANCE

5-1. INTRODUCTION.

5-2. This sections contains the safety requirements, required test equipment, and procedures for cleaning, removal and replacement, inspection, performance test, and adjustment for the Model 1110 Audio Oscillator.

5-3. SAFETY REQUIREMENTS.

5-4. Although this instrument has been designed in accordance with international safety standards, general safety precautions must be observed during all phases of operation, service and repair of the instrument. Failure to comply with the precautions listed in the Safety Summary at the front of this manual or with specific warnings given throughout this manual could result in serious injury or death. Service and adjustments should be performed only by qualified service personnel.

5-5. REQUIRED TEST EQUIPMENT.

5-6. Test equipment required for the performance tests, adjustments and troubleshooting is listed in Table 5-1. Any equipment that satisfies the critical specifications in the table may be substituted for the recommended models. However, the performance tests are based on the assumption that the recommended test equipment is used.

5-7. CLEANING PROCEDURE.

5-8. Painted surfaces can be cleaned with a commercial, spray-type window cleaner or with a mild soap and water solution.

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics used in the instrument. Recommended cleaning agents are isopropyl alcohol, a solution of 1 part kelite and 20 parts water, or a solution of 1 % mild detergent and 99 % water.

5-9. REMOVAL AND REPLACEMENT.

5-10. Instrument covers. Remove the instrument covers as follows:

a. Disconnect the power cord and all signal cables from the instrument.

b. Remove the three screws located at the rear of the cover and slowly lift the cover up and to the rear.

c. Turn the unit over and remove the bottom cover in the same manner as the top cover was removed.

d. To replace the covers reverse the removal procedure.

5-11. Display/Keyboard Access. To gain access to the display and keyboard proceed as follows:

a. Remove the instrument covers as described in paragraph 5-10.

b. Remove the three screws that hold the top trim extrusion and remove the trim strip.

CAUTION

When removing the display window be careful not to scratch the inner surface of the window.

c. Remove the plastic display window.

d. Turn the instrument over and remove the three screws that hold the bottom trim extrusion and remove the trim strip.

e. Tilt the bottom of the front panel away from the instrument until all switches are clear. Pull the front panel up to clear the center trim extrusion for access.

f. To replace the display/keyboard reverse the removal procedure.

5-12. Plug-in Circuit Boards. Remove the plug-in circuit boards as follows:

a. Remove the instrument covers as described in paragraph 5-10.

b. Grasp the circuit board extractors, pull up, and slide the circuit board up and out of the instrument.

c. To replace the circuit board reverse the removal procedure.

TABLE 5-1. RECOMMENDED TEST EQUIPMENT.

INSTRUMENT	CRITICAL SPECIFICATIONS	USAGE		MODEL
		PERFORMANCE EVALUATION	ADJUSTMENT	
AC/DC Calibrator	Frequency Range: 10 Hz to 200 kHz Level Range: 1mV to 300 V Flatness: + - 0.3 %; 10 - 30 Hz + - 0.25 %; 30 Hz - 200 kHz AC Accuracy: + - 0.1 %; 50 Hz - 50 kHz DC Accuracy: + - 0.05 %	X	X	Fluke Model 5100B-03
Frequency Counter	Frequency Range: 10 Hz to 200 kHz Accuracy: 0.1 ppm	X		HP Model 5345A
Distortion Analyzer	Frequency Range: 10 Hz to 140 kHz Level Range: 10 mV to 16 V Residual Distortion: .01 %; 10 Hz to 20 kHz .02 %; 20 KHz to 50 kHz .056 %; 50 kHz to 100 kHz .1 %; 100 kHz to 140 kHz	X		BEC Model 1130 or 1120
Digital Multimeter	AC Accuracy: + -1.0 % Resolution: 1 uV; 0 to 200 mV 10 uV; 200 to 2000 mV 100 uV; 2.0 to 20.0 V		X	Fluke Model 8840A-09
Frequency Standard	Frequency: 10 MHz Level: TTL compatible Accuracy: 0.1 ppm		X	House Standard
Variac/Line Monitor	20 % variation about 100, 120 or 240 volts		X	Powerstat Model 3PN116B
Balanced Cable	Two conductor shielded balanced line	X	X	Boonton 954021
Adapters (4 req.)	Single binding post to BNC (M)	X	X	Boonton 954018

5-13. Firmware Integrated Circuit. Remove the EPROM as follows:

- a. Remove the instrument top cover as described in paragraph 5-10.
- b. Remove the CPU board (green extractors). Refer to paragraph 5-12. Place the board on a flat, non-conductive working surface with the components up.

CAUTION

When removing and replacing an integrated circuit (IC) note the mark or notch used for pin number identification.

- c. Locate EPROM A6U14. Remove the IC with a straight pull away from the board.
- d. Install the replacement IC and replace the circuit board.

WARNING

There are voltages at various points in the instrument which can, if contacted, cause personal injury. Observe all safety precautions. Service and adjustments should be performed by trained service personnel only.

- e. Connect power to the instrument and set the LINE ON/OFF switch to ON.
- f. Depress the LCL/INIT key to initialize the instrument. The new firmware number will appear in the FREQUENCY display for a few seconds before the instrument resumes normal operation.
- g. Set the LINE ON/OFF switch to OFF, disconnect all power to the instrument and replace the instrument top cover.

5-14. Component Removal. Most components are readily accessible for inspection and replacement when the instrument covers are removed. Solid-state circuit components, mounted on plug-in circuit boards, are used throughout the instrument. Standard printed circuit board maintenance techniques are required for removal and replacement of parts. Excessive heat must be avoided; a low wattage soldering iron and suitable heat sinks should be used for all soldering and unsoldering operations.

5-15. INSPECTION.

5-16. If an equipment malfunction occurs, perform a visual inspection of the instrument. Inspect for signs of damage caused by excessive shock, vibration, or overheating, such as

broken wires, loose hardware and parts, loose electrical connections, or accumulations of dirt and other foreign matter. Correct any problems discovered, then perform the performance tests to verify that the instrument is operational. If a malfunction persists or the instrument fails any of the performance tests, refer to the adjustment procedure. After the instrument has been adjusted, perform the performance tests again to verify instrument operation.

5-17. PERFORMANCE TESTS.

5-18. The performance tests should be performed about every 12 months or after the instrument has been repaired. The performance tests may also be performed when the instrument is first received to verify instrument performance.

5-19. Frequency Accuracy. Depress the LCL/INIT key on the Model 1110 to initialize the instrument. Connect the SYNC output on the rear panel of the oscillator to the Frequency Counter CHANNEL A input and set the Frequency Counter controls as follows:

FUNCTION	FREQ A
GATE TIME	100mS
DISPLAY POSITION	AUTO
LEVEL	PRESET
SLOPE	+
ATTEN	1 MEG, X1
AC/DC	AC
CHECK/COM/SEP	SEP

5-20. For each test frequency listed in table 5-2 set the Model 1110 to the test frequency, verify the frequency accuracy and record the result, pass or fail, in Table 5-2.

5-21. Output Impedance Accuracy. Depress the LCL/INIT key on the Model 1110 to initialize the instrument. Connect the HI and LOW outputs using the balanced cable and adapters to the Analyzer HI and LOW inputs. Perform the following procedure.

- a. On the Model 1110 enter a level of 3.000 Volts and depress the AF ON key.
- b. Enable the Analyzer ratio mode.
- c. Connect the 600 ohm load across the binding post adapters at the input of the Analyzer.
- d. Note the display and calculate the output impedance using the following formula and record Z_{OUT} in Table 5-3.

$$Z_{OUT} = \left(\frac{100.6 \%}{DISP \%} - 1 \right) 596.4$$

- e. Disable the ratio mode and remove the 600 ohm load.
- f. Depress the 150 OHMS key on the Model 1110.
- g. Enable the Analyzer ratio mode.
- h. Connect the 150 ohm load across the binding post adapters at the input of the Analyzer.
- i. Note the display and calculate the output impedance using the following formula and record Z_{OUT} in Table 5-3.

$$Z_{OUT} = \left(\frac{100.15 \%}{DISP \%} - 1 \right) 149.8$$

- j. Disable the ratio mode and remove the 150 ohm load.
- k. Depress the 50 OHMS key on the Model 1110.
- l. Enable the Analyzer ratio mode.
- m. Connect the 50 ohm load across the binding post adapters at the input of the Analyzer.
- n. Note the display and calculate the output impedance using the following formula and record Z_{OUT} in Table 5-3.

$$Z_{OUT} = \left(\frac{100.05 \%}{DISP \%} - 1 \right) 49.98$$

- o. Disable the ratio mode and remove the 50 ohm load.

5-22. Level Accuracy. In this test the Analyzer level reference is set using the precision calibrator. The accuracy of the Model 1110 is then measured at the same test levels and compared to the measurements using the calibrator thereby eliminating the Analyzer measurement errors.

5-23. Depress the LCL/INIT keys on the Audio Analyzer and the Model 1110 to initialize the instruments. Depress the AF ON and 50 OHMS keys and enable the Analyzer floating mode. Perform the following procedure for each test level listed in Table 5-4.

- a. Connect the AC Calibrator to the Analyzer HI and LOW inputs using the balanced cable and adapters.
- b. On the Audio Analyzer enter the Model 5100B level in the ANALYZER display window to set and hold the input level range.
- c. On the AC Calibrator enter the Model 5100B level at a frequency of 1 kHz.

- d. After the Analyzer display settles enable the ratio mode to set the calibrator level reference.

- e. Connect the Model 1110 HI and LOW outputs to the Analyzer HI and LOW inputs using the balanced cable and adapters.

- f. Enter the Model 1110 test level at a frequency of 1 kHz and record the measurement in the ACTUAL column in Table 5-4.

5-24. AC Level Flatness. The level flatness test is made using the Analyzer ratio mode where a level reference is set at a frequency of 1 kHz and at a specific test level. The frequency is then varied and the resultant relative amplitude errors are measured. In this test the Analyzer flatness is first verified using the precision AC calibrator and recorded. The Model 1110 flatness is then measured at the same test levels and compared to the measurements using the calibrator thereby eliminating the Analyzer measurement errors.

5-25. Depress the LCL/INIT key on the Audio Analyzer to initialize the instrument and enter special function 17 to enable the slow detector mode. Connect the Wideband Calibrator output using the balanced cable and adapters to the Analyzer HI and LOW inputs and connect the 50 ohm load across the binding post adapters at the Analyzer input. Perform the following procedure for each test level listed in Table 5-5.

- a. On the Calibrator enable the wideband source output and enter the Model 5100B test level at a frequency of 1 kHz.
- b. On the Audio Analyzer enter the calibrator level in the ANALYZER display window to set and hold the input level range.
- c. Enable the Analyzer level ratio mode to set the flatness reference.
- d. On the Calibrator enter the test frequencies between 10 Hz and 100 kHz indicated in Table 5-5 and record the Analyzer ratio measurements in the REFERENCE column.

5-26. Depress the LCL/INIT keys on the Audio Analyzer and the Model 1110 to initialize the instruments. Connect the HI and LOW outputs using the balanced cable and adapters to the Analyzer HI and LOW inputs. Depress the AF ON and 50 OHMS keys. Enable the Analyzer floating mode and connect the 50 ohm load across the binding post adapters at the Analyzer input. Perform the following procedure for each test level listed in Table 5-5.

- a. On the Model 1110 enter the test level at a frequency of 1 kHz. Before entering the 6.0 mV down-scale test level,

the 300 mV range must be held by entering special function 18 while the 300 mV level is set.

- b. On the Audio Analyzer enter the Model 5100B test level in the ANALYZER display window to set and hold the input level range.
- c. Enable the Analyzer level ratio mode to set the flatness reference.
- d. On the Model 1110 enter the test frequencies indicated in Table 5-5.
- e. Note the display and calculate the actual flatness by subtracting the value in the REFERENCE column in Table 5-5 from the displayed measurement and record the result in the ACTUAL column. At the 150 kHz test frequency subtract the 100 kHz value in the REFERENCE column from the displayed measurement and record the result.

5-27. Residual Distortion and Noise. Depress the LCL/INIT keys on the Audio Analyzer and the Model 1110 to initialize the instruments. Connect the HI and LOW outputs using the balanced cable and adapters to the Analyzer HI and LOW inputs. Depress the AF ON and 50 OHMS keys. Enable the Analyzer floating mode and connect the 50 ohm load across the binding post adapters at the Analyzer input. Perform the following procedure for each test level listed in Table 5-6.

- a. Enter the Model 1110 test level and frequency listed in Table 5-6.
- b. Enable the low-pass filter on the Audio Analyzer specified in the BW column.
- c. Record the results, pass or fail, in Table 5-6.

TABLE 5-2. FREQUENCY ACCURACY TEST RECORD.

AUDIO OSCILLATOR		FREQUENCY ACCURACY		
FREQUENCY	MINIMUM	PASS/FAIL		MAXIMUM
190.000 Hz	189.997 Hz	PASS	FAIL	190.003 Hz
1900.00 Hz	1899.97 Hz	PASS	FAIL	1900.03 Hz
19000.0 Hz	18999.7 Hz	PASS	FAIL	19000.3 Hz
150000 Hz	149997 Hz	PASS	FAIL	150003 Hz

TABLE 5-3. SOURCE IMPEDNCE ACCURACY TEST RECORD.

IMPEDANCE	TOLERANCE	Z _{OUT}
50 ohms	+ - 1.0 ohm	_____
150 ohms	+ - 1.5 ohms	_____
600 ohms	+ - 6.0 ohms	_____

TABLE 5-4. AC LEVEL ACCURACY TEST RECORD.

TEST LEVEL		ANALYZER AC LEVEL MEASUREMENT		
Model 5100B	Model 1110	MINIMUM	ACTUAL	MAXIMUM
1.200 mV	0.600 mV	46.95	_____	52.95
3.000 mV	3.000 mV	98.95	_____	100.95
30.00 mV	30.00 mV	99.45	_____	100.45
300.0 mV	300.0 mV	99.45	_____	100.45
3.000 V	3.000 V	99.45	_____	100.45
16.000 V	16.000 V	99.45	_____	100.45

TABLE 5-5. AC LEVEL FLATNESS TEST RECORD.

TEST SETTINGS			ANALYZER AC RATIO MEASUREMENT				
Model 5100B	Model 1110	FREQUENCY	REFERENCE	MINIMUM	ACTUAL	MAXIMUM	
1.5 V	3.0 V	10 Hz	_____	-0.50	_____	+0.50	
1.5 V	3.0 V	50 kHz	_____	-0.50	_____	+0.50	
1.5 V	3.0 V	100 kHz	_____	-1.00	_____	+1.00	
	3.0 V	150 kHz		-1.50	_____	+1.50	
15 mV	30 mV	50 kHz	_____	-0.50	_____	+0.50	
15 mV	30 mV	100 kHz	_____	-1.00	_____	+1.00	
	30 mV	150 kHz		-1.50	_____	+1.50	
150 mV	300 mV	50 kHz	_____	-0.50	_____	+0.50	
150 mV	300 mV	100 kHz	_____	-1.00	_____	+1.00	
	300 mV	150 kHz		-1.50	_____	+1.50	
3.0 mV	6.0 mV	50 kHz	_____	-0.50	_____	+0.50	
3.0 mV	6.0 mV	100 kHz	_____	-1.00	_____	+1.00	
	6.0 mV	150 kHz		-1.50	_____	+1.50	

TABLE 5-6. RESIDUAL DISTORTION AND NOISE TEST RECORD.

AUDIO OSCILLATOR		DISTORTION MEASUREMENT		
LEVEL	FREQUENCY	BW	PASS/FAIL	MAXIMUM
16.000 V	10 Hz	80 kHz	PASS FAIL	-80.00 dB
16.000 V	20 Hz	80 kHz	PASS FAIL	-80.00 dB
16.000 V	100 Hz	80 kHz	PASS FAIL	-80.00 dB
16.000 V	1000 Hz	80 kHz	PASS FAIL	-80.00 dB
16.000 V	10000 Hz	80 kHz	PASS FAIL	-80.00 dB
16.000 V	20000 Hz	80 kHz	PASS FAIL	-80.00 dB
16.000 V	50000 Hz	220 kHz	PASS FAIL	-74.00 dB
16.000 V	100000 Hz	500 kHz	PASS FAIL	-65.00 dB
16.000 V	140000 Hz	500 kHz	PASS FAIL	-60.00 dB
200.0 mV	10 Hz	80 kHz	PASS FAIL	-80.00 dB
200.0 mV	20 Hz	80 kHz	PASS FAIL	-80.00 dB
200.0 mV	100 Hz	80 kHz	PASS FAIL	-80.00 dB
200.0 mV	1000 Hz	80 kHz	PASS FAIL	-80.00 dB
200.0 mV	10000 Hz	80 kHz	PASS FAIL	-80.00 dB
200.0 mV	20000 Hz	80 kHz	PASS FAIL	-80.00 dB
200.0 mV	50000 Hz	220 kHz	PASS FAIL	-74.00 dB
178.6 mV	100000 Hz	500 kHz	PASS FAIL	-65.00 dB
100.0 mV	140000 Hz	500 kHz	PASS FAIL	-60.00 dB

5-28. ADJUSTMENTS.

5-29. The Model 1110 adjustments are listed in Table 5-7. Test equipment required for the adjustments is listed in Table 5-1.

5-30. A11 Power Supply Adjustment.

5-31. The power supply has only one adjustment which is the power supply Power Fail adjustment. The Power Fail adjustment sets the low line trip level that interrupts the processor operation until the proper AC voltage is applied.

5-32. A11R4 Power Fail Adjustment. Perform the adjustment as follows:

- a. Disconnect all power to the Model 1110 and remove the top cover.
- b. Set the rear panel line voltage switch to the appropriate voltage.
- c. Verify that the line fuse is the proper value as listed on the LINE VOLTAGE SELECT chart located on the rear panel.
- d. Connect the variac to an appropriate power source and adjust for a line indication of nominal - 10 % (90, 108, 200 or 216 volts).

WARNING

There are voltages at various points in the instrument which can, if contacted, cause personal injury. Observe all safety precautions.

e. Connect the Model 1110 power cord to the variac and set the LINE ON/OFF switch to ON.

f. Observe the display and adjust A11R4 clockwise until the display just blanks, then slowly counterclockwise until the display returns.

5-33. A5 C.P.U. Adjustment.

5-34. The only adjustment on the C.P.U. Board is the Timebase Frequency adjustment which is adjusted to provide the specific frequency accuracy for the system time standard.

5-35. A5Y1 Timebase Frequency Adjustment. Perform the procedure as follows:

- a. Remove the IEEE-488 interface cable on the C.P.U. Board.
- b. Remove the cover screw in the top of A5Y1 to expose the trimmer adjustment.
- c. Connect the House Standard frequency reference to the rear panel X CLK input.
- d. Set the Option switches A4S1-7 and A4S1-8 to the open position and depress the LCL/INIT key.
- e. Observe the Audio Oscillator display and adjust A5Y1 until the display indicates 10000.00 kHz +- 1 count.
- f. Set the Option switches A4S1-7 and A4S1-8 to the closed position, replace the cover screw and cable.

TABLE 5-7. LIST OF ADJUSTMENTS.

ADJUSTMENT		LOCATION
A11R6	Power Fail	Power Supply Board
A5Y1	Timebase Frequency	C. P. U. Board
A6R23	Oscillator Level	Source Board
A7R21	Attenuator Bit 2	Output Board
A7R17	Attenuator Bit 1	Output Board
A7R15	Attenuator Bit 0	Output Board

5-36. A7 Output Board Adjustments.

The Output Board adjustments consist of three attenuator adjustments which trim the most significant bits of the programmable attenuator for optimum level accuracy.

5-37. A7R21, A7R17, and A7R15 Adjustments.

Perform the adjustments as follows:

- a. Depress the LCL/INIT key on the Model 1110 to initialize the instrument. Connect the Model 1110 output HI and LOW to the Multimeter input HI and LOW using the balanced cable and adapters and depress the AF ON and 50 OHMS keys.
- b. Set the Multimeter to measure AC level.
- c. Set the level (open circuit) to 511 mV.
- d. Observe the Multimeter display.
- e. Set the level to 512 mV and adjust A7R21 for an increase of 1 mV $\pm$ 0.3 mV above the measurement in step d above.
- f. Set the level to 1023 mV.
- g. Observe the Multimeter display.
- h. Set the level to 1024 mV and adjust A7R17 for an increase of 1 mV $\pm$ 0.5 mV above the measurement in step g above.
- i. Set the level to 2047 mV.
- j. Observe the Multimeter display.
- k. Set the level to 2048 mV and adjust A7R15 for an increase of 1 mV $\pm$ 0.5 mV above the measurement in step j above.

5-38. A6 Source Board Adjustments.

The only adjustment on the Source Board is the Output Level adjustment which sets the full scale output level of the Model 1110.

5-39. A6R2 Output Level Adjustment.

Perform the adjustments as follows:

- a. Connect the Calibrator output to the Multimeter input using the balanced cable and adapters and set the Multimeter to measure AC level.

- b. Set the Calibrator to 1.000 kHz and 3.000 volts and enable the Calibrator output.

- c. After the Multimeter measurement settles, depress the OFFSET key to enable the level ratio mode.

- d. Disconnect the Calibrator and connect the Model 1110 output HI and LOW to the Multimeter input using the balanced cable and adapters.

- e. Set the Model 1110 level to 3.000 volts at a frequency of 1 kHz and depress the AF ON and 50 OHMS keys.

- f. Note the Multimeter display and adjust A6R23 for a Multimeter level ratio display of 0.00 $\pm$ 1.0 mV.

5-40. TROUBLESHOOTING. Instrument malfunction will generally be evident from front panel indications, or IEEE-488 bus responses. The problems will fall into two general categories: catastrophic failures or selective failure of one subsystem.

5-41. Catastrophic failures would generally cause the Model 1110 to be completely inoperative. For instance, if the microprocessor was not operating properly, the display would contain meaningless symbols and the keyboard would not be responsive. Such failures are usually located in the power supply circuits, interconnecting cables, and the CPU plug-in board.

5-42. Selective failures and performance out of specification are usually limited to one section of the instrument and will be evident from manipulation of the front panel controls. For example, incorrect or erratic amplitude over the entire level range of the Model 1110 will indicate a fault in the ALC circuits on the Source plug-in board. However, if the error is limited to one specific amplitude range, the fault may be found in the level ranging circuits on the Output plug-in board. Further isolation of the problem requires an understanding of the simplified block diagrams detailed in the theory of operation section of this manual and experience in troubleshooting analog and digital circuits.

5-43. TROUBLE LOCALIZATION.

5-44. Special Diagnostic Function Codes. Special function codes 30 and 31 are provided to localize selective failures in the analog and frequency counter circuits. When entered, these codes continuously execute the designated test sequence until the LCL/INIT key is depressed.

5-45. During the initialization sequence and execution of the counter test, error codes are reported if a fault is encountered. Table 5-7 lists the ranges, error codes and probable causes to aid in localizing a fault.

5-46. DAC Test Code. Contained in the Model 1110 are two digital-to-analog converters (DAC) which can be configured to generate a low frequency ramp waveform using special function 30. A coarse stepped ramp waveform is usually an indication of missing data bits in the DAC circuits. The display will indicate the "dac tst" message when the test is active.

5-47. The first 12 bit DAC, A7U1, is used to fine tune the oscillator frequency and is located on the Output plug-in board. The ramp can be found at A7U2 pin 7 (TP3) and will have a peak to peak amplitude of 20 volts from -6 to +14 volts.

5-48. The remaining 12 bit DAC is used to generate the rear panel X AXIS output. The ramp from this DAC can be found

at the rear panel recorder output connector and will have a peak amplitude extending from 0 to +5 volts. The PEN output is toggled between 0 and +5 volts at the ramp frequency to provide an external sync signal.

5-49. Counter Plug-in Board Test Code. The period counter can be tested using special function 31. In this test sequence the counter is configured to measure the timebase reference. The reference is divided in decade increments from 1 to 10,000 by the period ranging circuits. Each of the five frequency ranges is sequentially checked for accuracy while the LEVEL display indicates the range being tested. The FREQUENCY display will indicate an error code if a fault is evident on the tested range.

TABLE 5-8. DIAGNOSTIC ERROR CODE DESCRIPTIONS.

FAULT	DESCRIPTION	PROBABLE CAUSE
Error 30	10 - 125 Hz freq. lock	A6Q5, A6Q17, A6U13
Error 31	125 - 1250 Hz freq. lock	A6Q4, A6Q16, A6U13
Error 32	1.25 - 7.5 kHz freq. lock	A6Q3, A6Q15, A6U13
Error 33	7.5 - 55 kHz freq. lock	A6Q2, A6Q14, A6U13
Error 34	55 - 150 kHz freq. lock	A6Q2-Q5, A6Q14-Q17, A6U13
All 30-34	10 Hz - 140 kHz freq. lock	A6Q18-25, A6Q6-13, A6U1, A6U7, A6U8, A6U13-17, A7U1-U3
Error 50	199.999 Hz range	A4U5, A4U9, A4U13
Error 51	1.99999 kHz range	A4U6, A4U9, A4U13
Error 52	19.9999 kHz range	A4U6, A4U9, A4U13
Error 53	199.999 kHz range	A4U7, A4U9, A4U13
Error 54	1999.99 kHz range	A4U7, A4U9, A4U13
All 50-54	Counter accumulator	A4U5, A4U9, A4U10, A4U3, A4U12-16, A5Y1

SECTION VI

PARTS LIST

6-1. INTRODUCTION.

6-2. The replaceable parts for the Model 1110 are listed in Table 6-2. The replaceable parts list contains the reference

symbol, description, manufacturer, and both the BEC and manufacturer part numbers. Table 6-1 lists the manufacturer's federal supply code numbers.

TABLE 6-1. MANUFACTURER'S FEDERAL SUPPLY CODE NUMBERS.

01121	Allen Bradley	31781	EDAC
01295	Texas Instruments	31918	ITT Schadow, Inc.
02114	Ferroxcube Corp.	32293	Intersil, Inc.
02735	RCA Solid State Division	32575	AMP
03888	Pyrofilm (KDI)	33297	NEC
04222	AVX Ceramics Company	33883	RMC
04713	Motorola Semiconductor	34335	Advanced Micro Devices
04901	Boonton Electronics Corporation	34371	Harris Semiconductor
06383	Panduit Corporation	49956	Raytheon Corporation
06665	Precision Monolithics	51406	Murata Corporation of America
06776	Robinson Nugent, Inc.	51640	Analog Devices, Inc.
07263	Fairchild Semiconductor	54420	Dage - MTI
11961	Semicon	54426	Buss Fuses
13812	Dialco Division of Amperex	54473	Panasonic
14655	Cornell-Dubilier	56289	Sprague Electric Company
14752	Electro Cube, Inc.	56708	Zilog, Inc.
17856	Siliconix, Inc.	57582	Kahgan Electronics Corporation
18324	Signetics Corporation	61637	Kemet - Union Carbide
19505	Applied Eng'r. Products	64537	Pyrofilm (KDI)
19701	Mepco Electra	71450	CTS Corporation
20307	Arco - Micronics	73138	Beckman Instruments, Helipot Division
24226	Gowanda Electronics	74970	E. F. Johnson
27014	National Semiconductor	75915	Littlefuse
27264	Molex, Inc.	81073	Grayhill
27735	F-Dyne Electronics	82389	Switchcraft
27802	Vectron Labs	91637	Dale Electronics
28480	Hewlett-Packard Corporation	S4217	United Chemicon, Inc.
31313	Components Corporation		

TABLE 6-2. REPLACEABLE PARTS LIST.

SECTION VII SCHEMATIC DIAGRAMS

TABLE 7-1. LIST OF SCHEMATICS.

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Figure 7-26. Key Board A13 Schematic	7-29
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Figure 7-28. Amplifier Board A24 Schematic	7-30

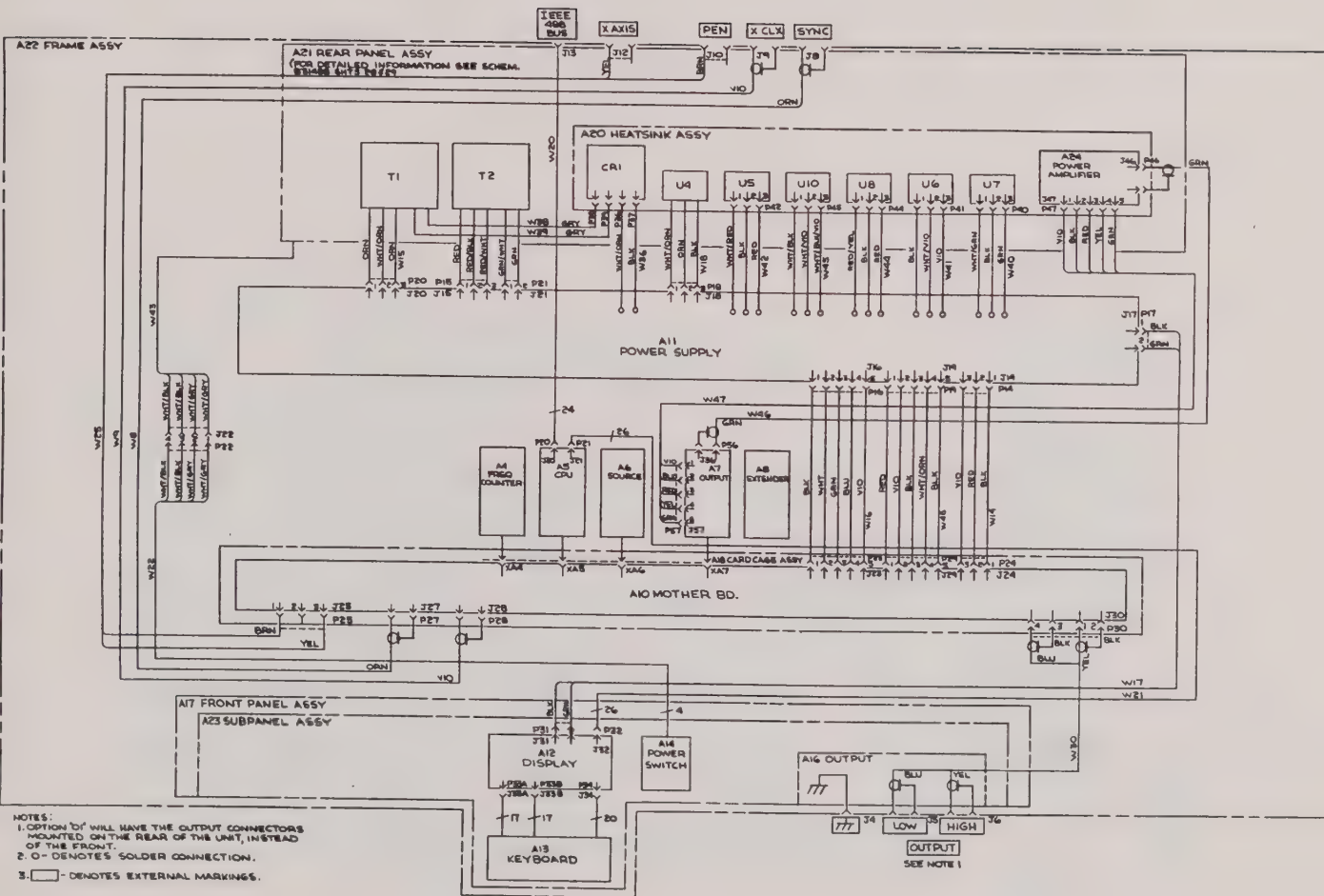


Figure 7-1. Main Frame Schematic.

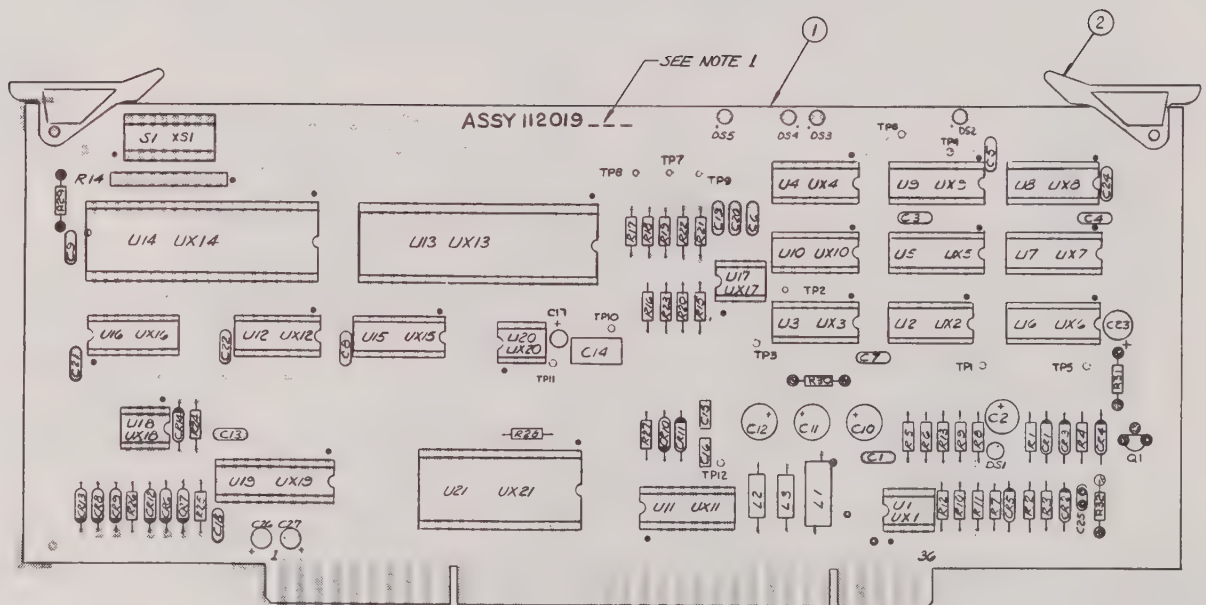


Figure 7-2. Counter Board A4 Parts Location Diagram.

NOTES:

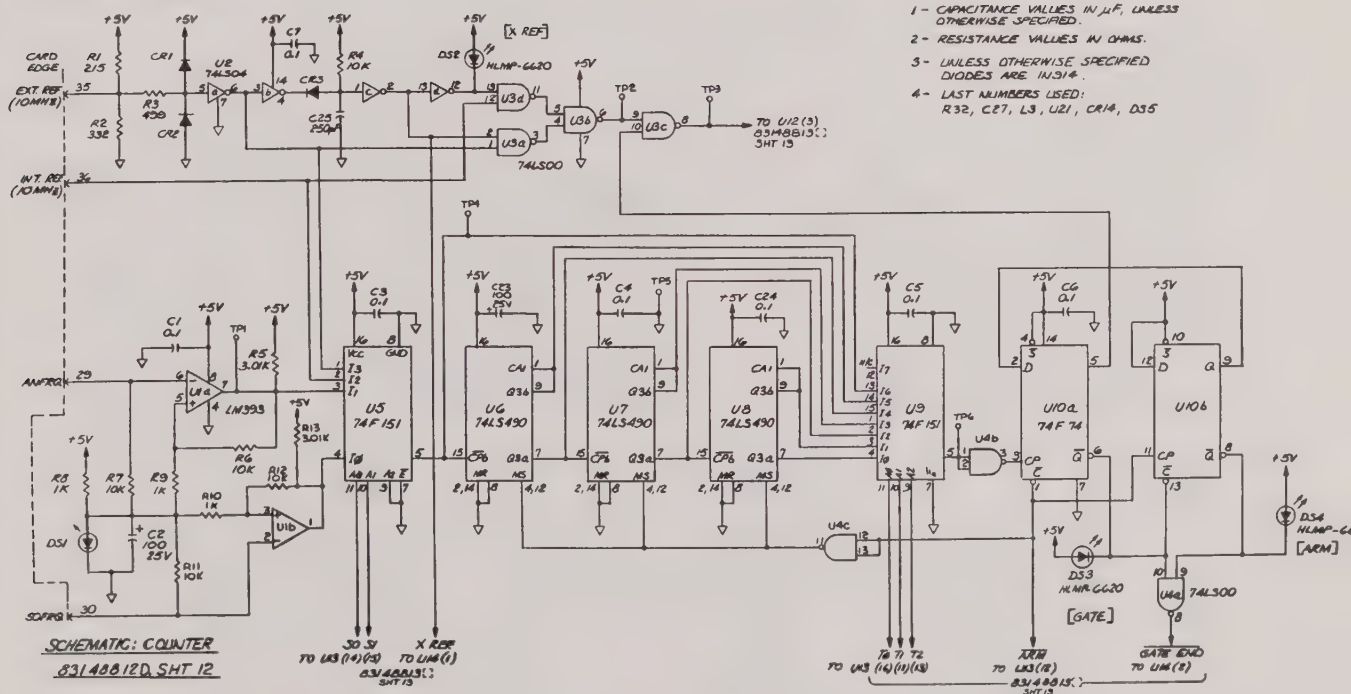


Figure 7-3. Counter Board A4 Schematic Sheet 1.



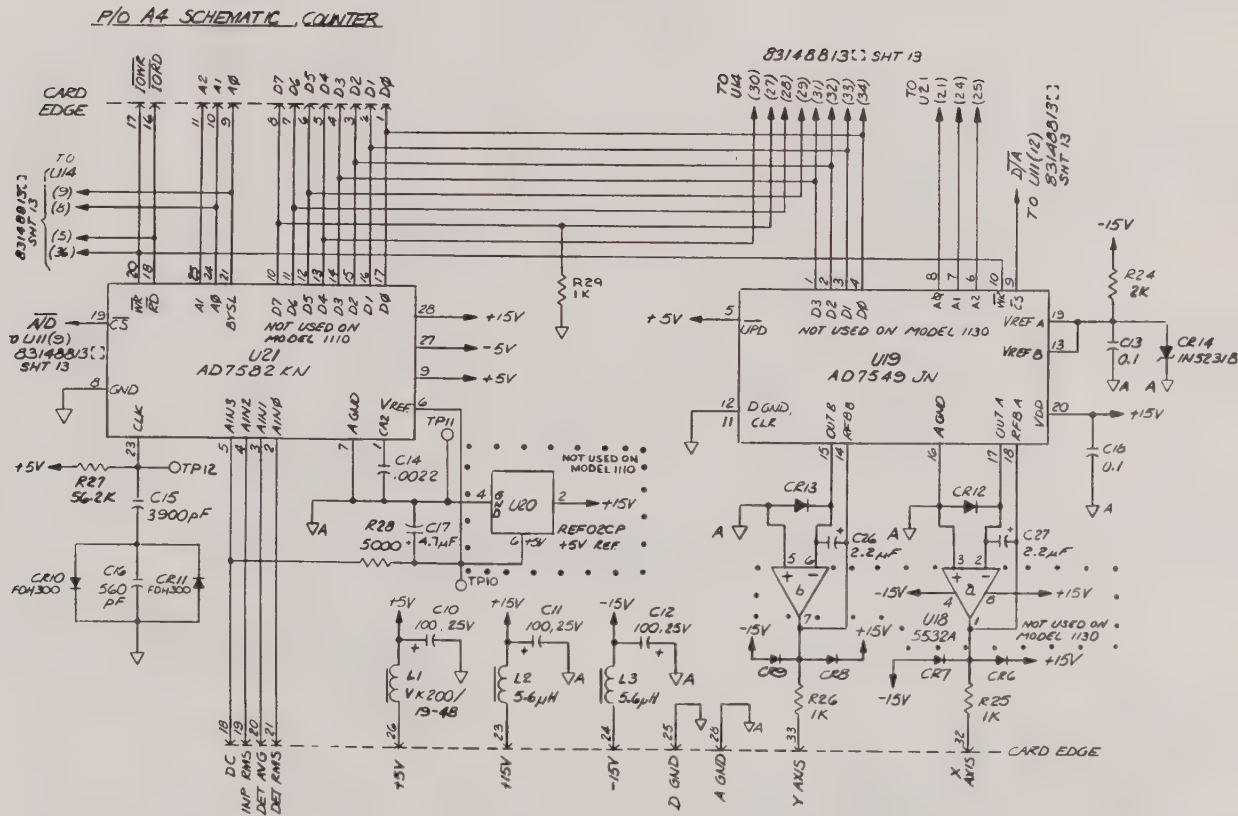
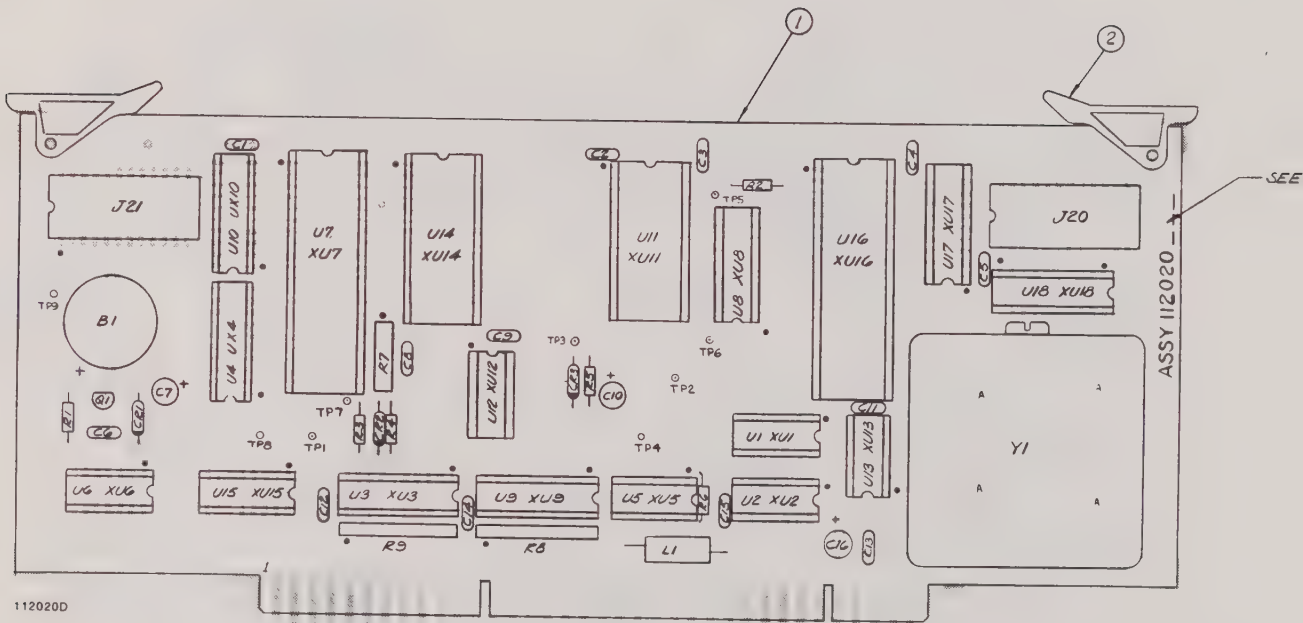


Figure 7-5. Counter Board A4 Schematic Sheet 3.



NOTES:
 1- MARK FINAL ASSY PART NUMBER WITH 1/8 INCH
 HIGH BLACK CHARACTERS. REFER TO MANUFACT-
 URING ORDER FOR COMPLETE PART NUMBER.

Figure 7-6. C.P.U. Board A5 Parts Location Diagram.

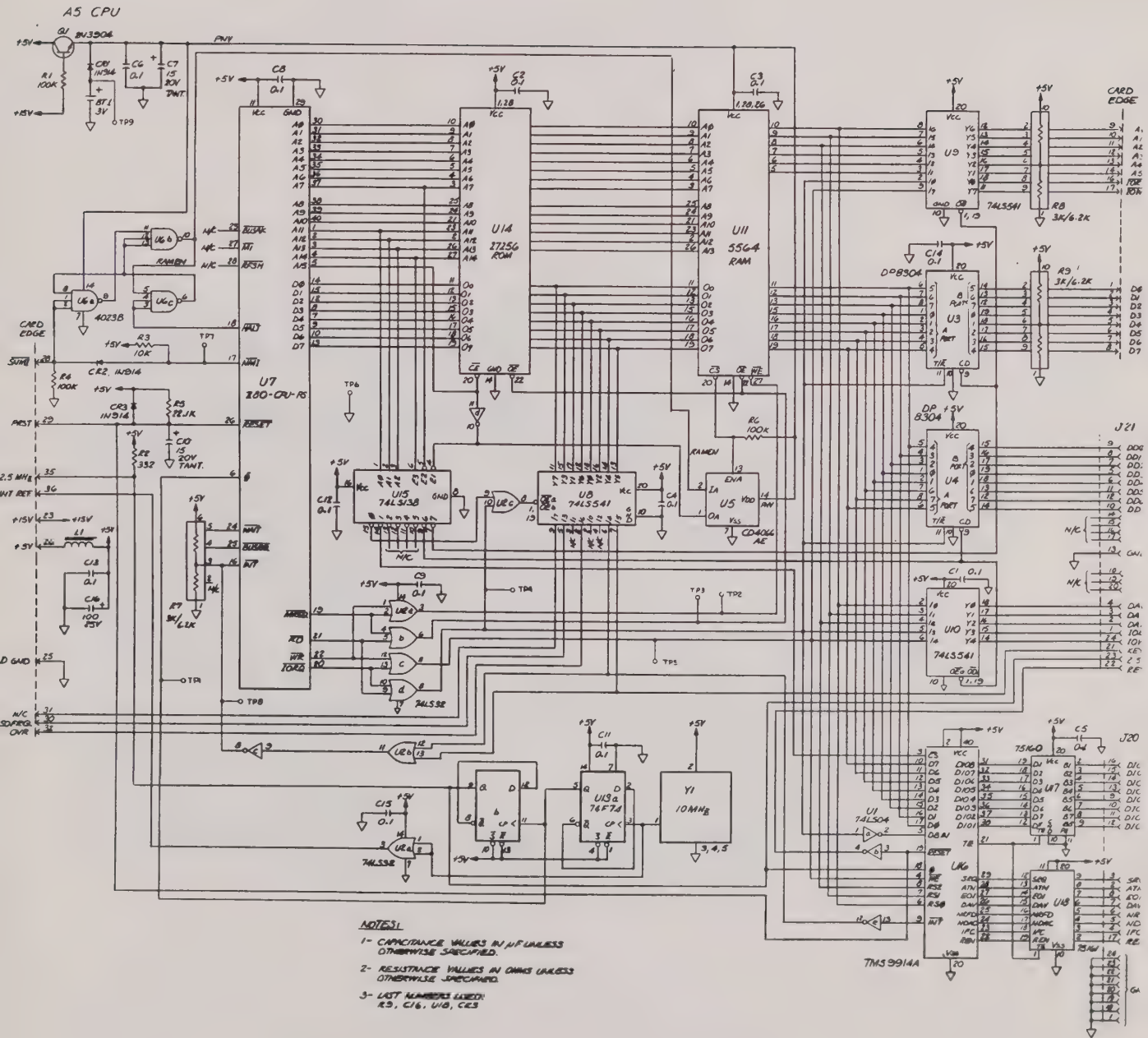
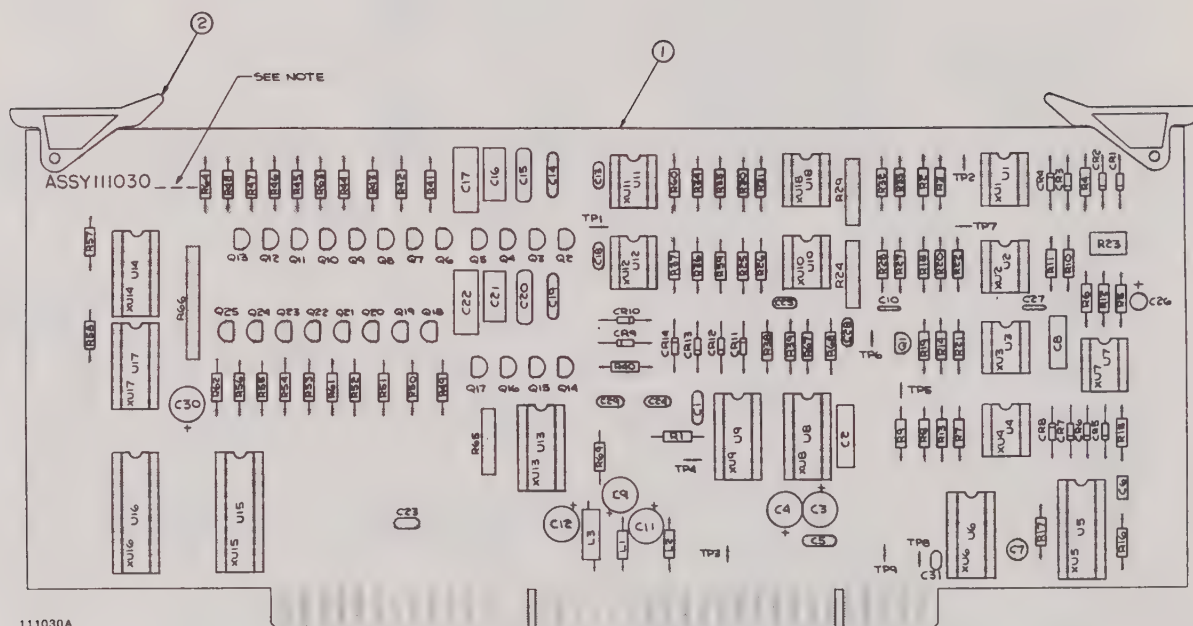


Figure 7-7. C.P.U. Board A5 Schematic.



NOTE:
MARK FINAL ASSY PART NUMBER WITH 1/8" HIGH
BLACK CHARACTERS. REFER TO MANUFACTURING
ORDER FOR COMPLETE PART NUMBER.

Figure 7-8. Source Board A6 Parts Location Diagram.

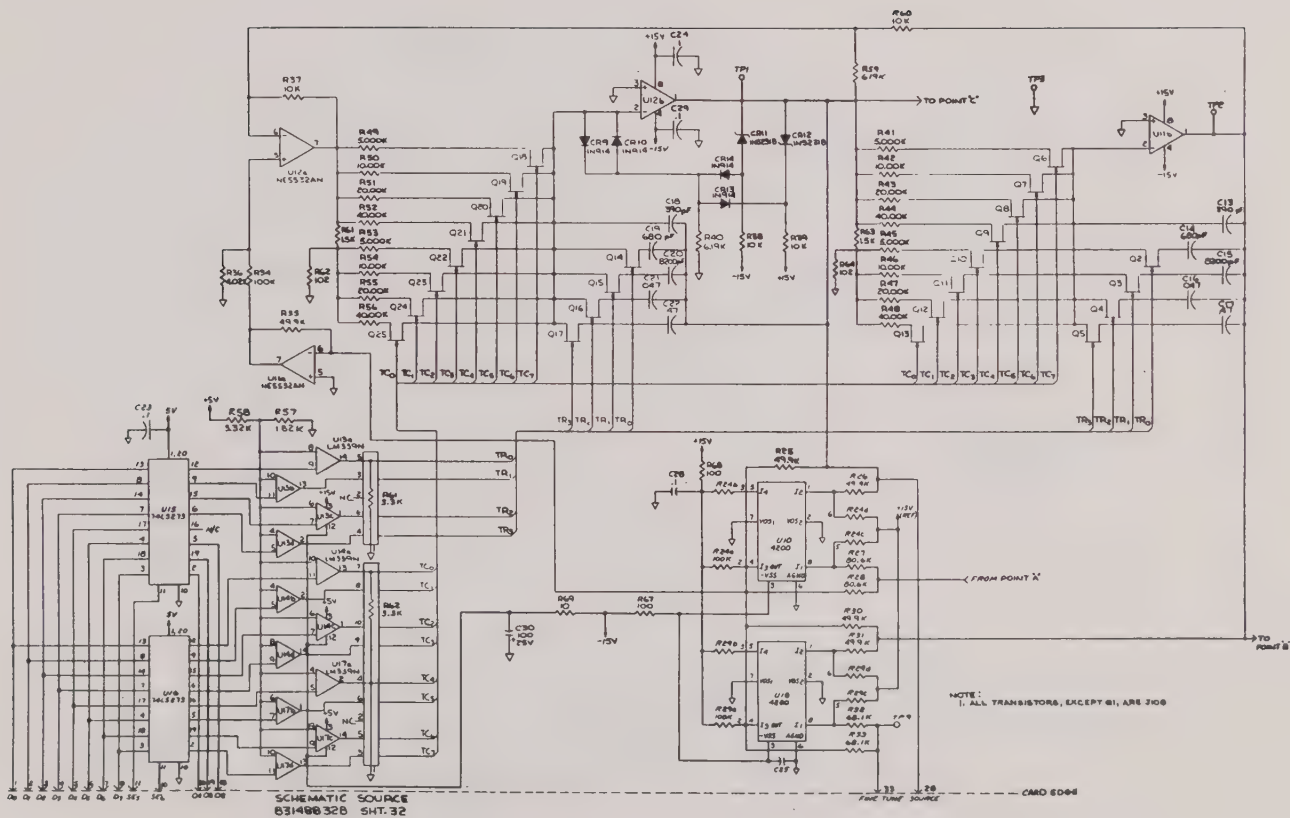


Figure 7-9. Source Board A6 Schematic Sheet 1.

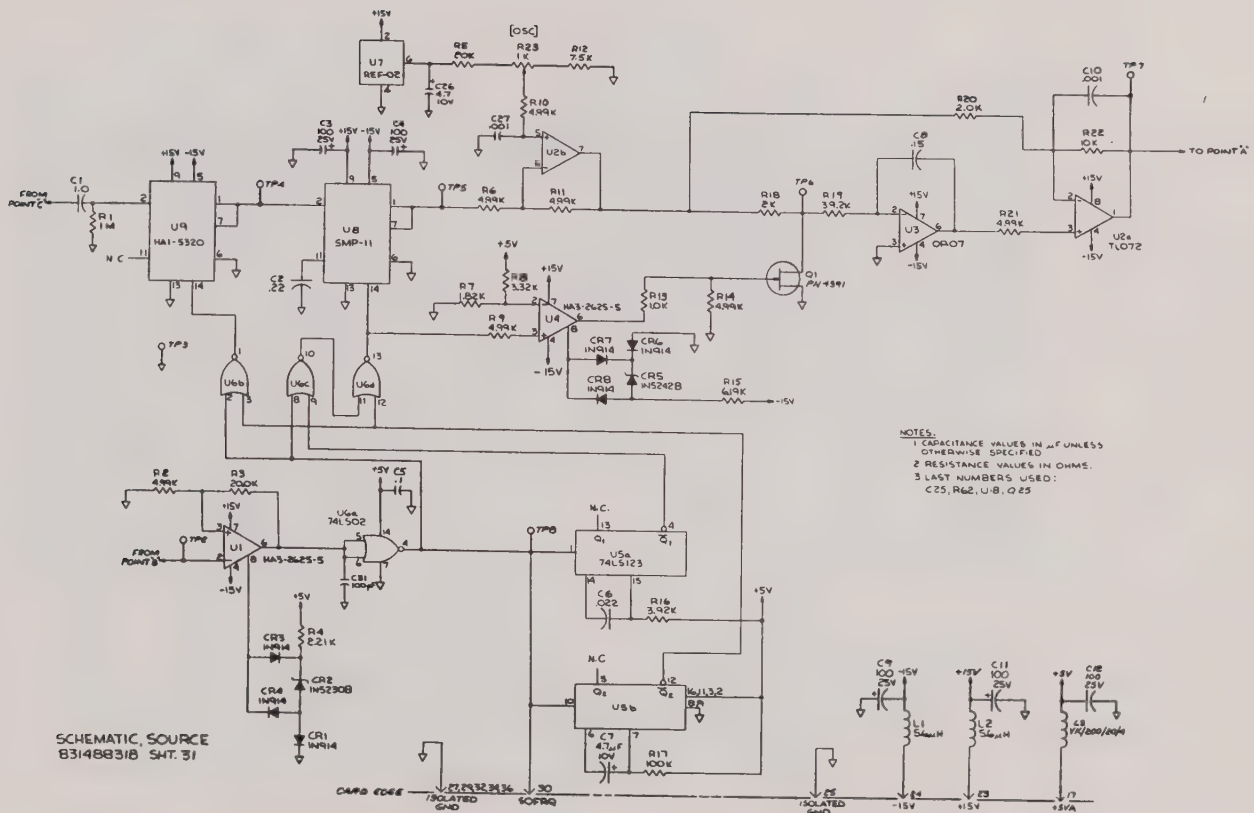
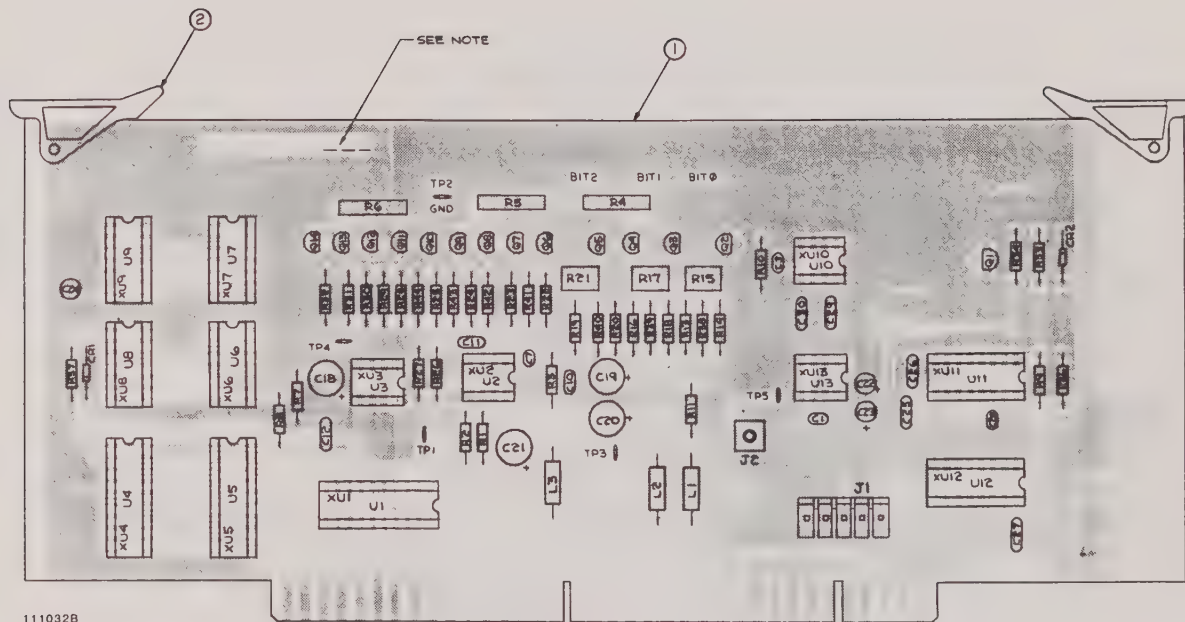


Figure 7-10. Source Board A6 Schematic Sheet 2.



NOTE:
 MARK FINAL ASSY PART NUMBER WITH $\frac{1}{8}$ " HIGH
 BLACK CHARACTERS, REFER TO MANUFACTURING
 ORDER FOR COMPLETE PART NUMBER.

Figure 7-11. Output Board A7 Parts Location Diagram.

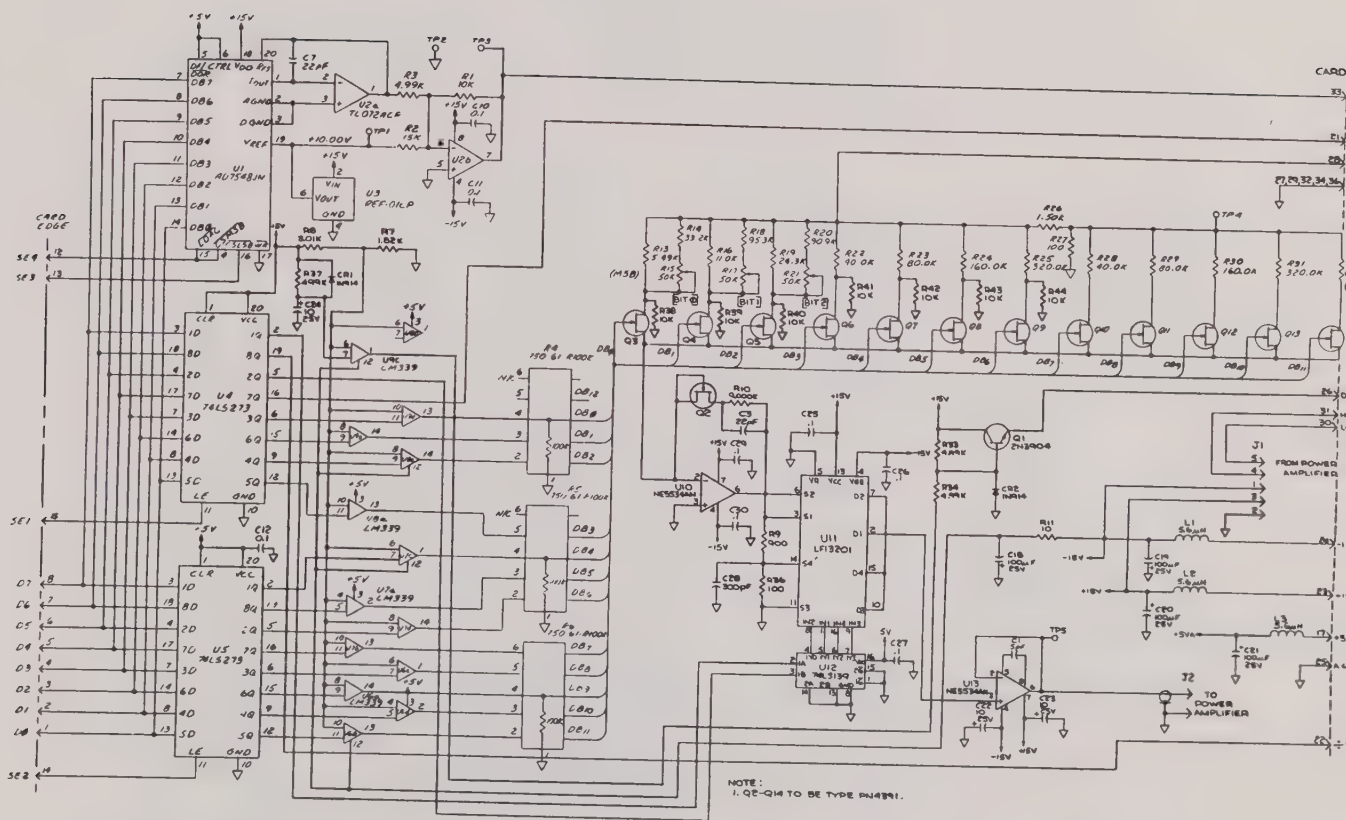


Figure 7-12. Output Board A7 Schematic.

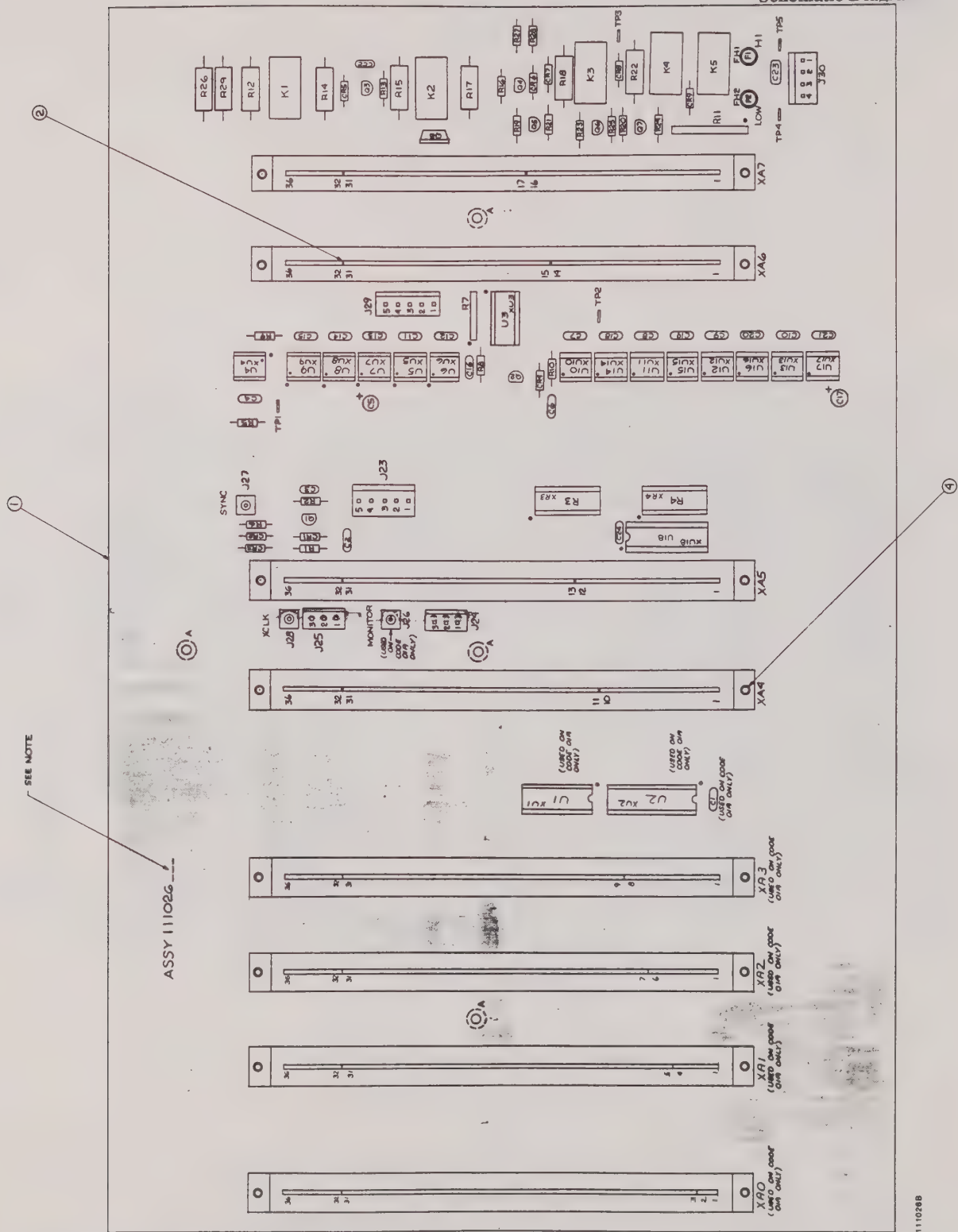


Figure 7-13. Mother Board A10 Parts Location Diagram.



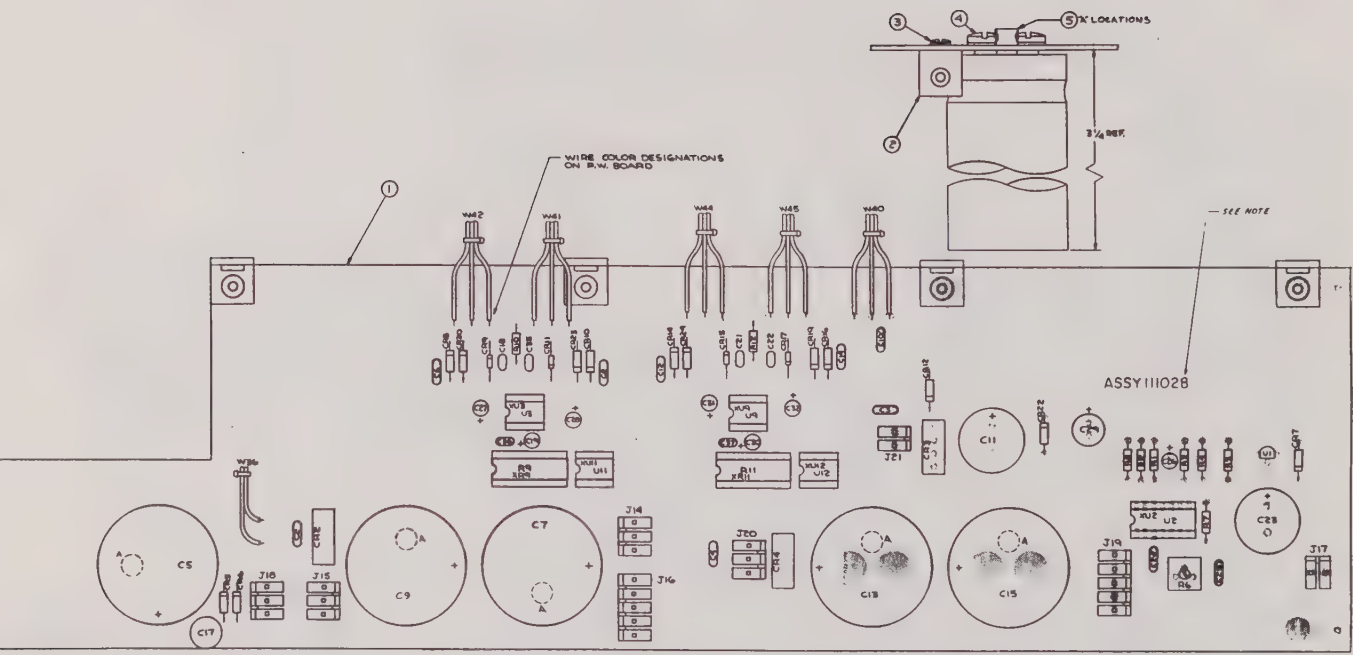


Figure 7-15. Power Supply A11 Parts Location Diagram.

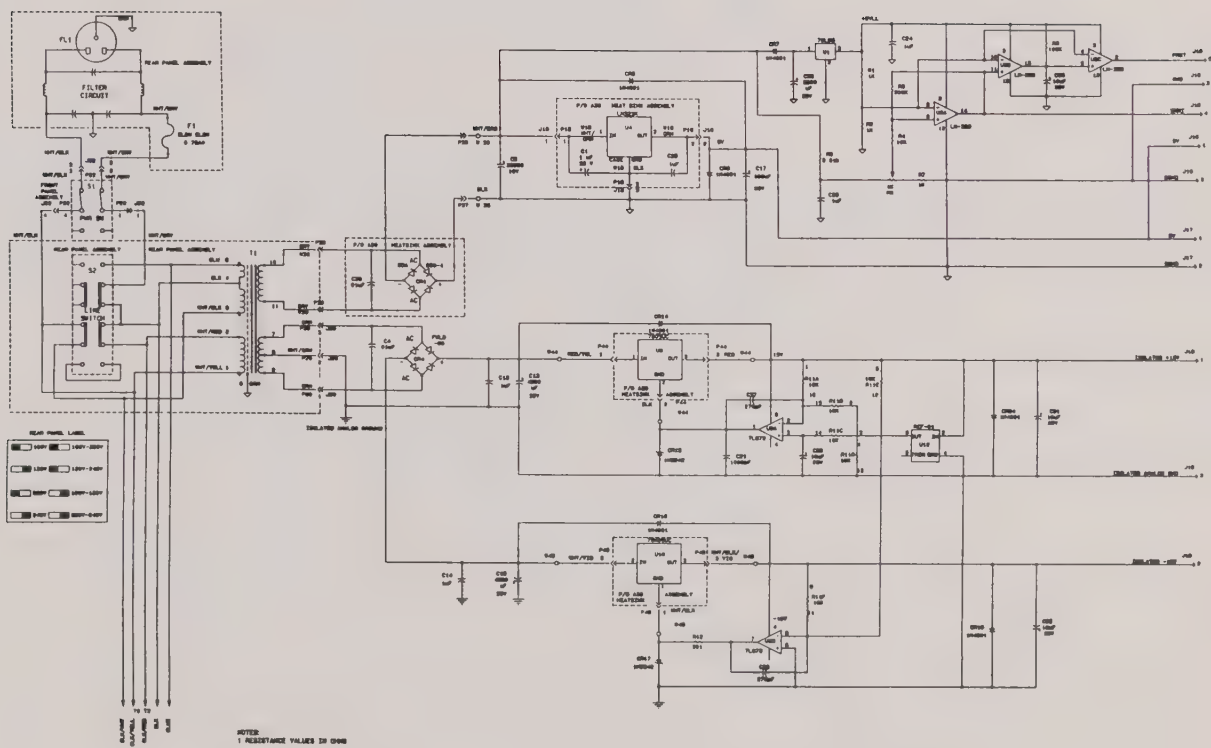


Figure 7-16. Power Supply A11 Schematic Sheet 1.

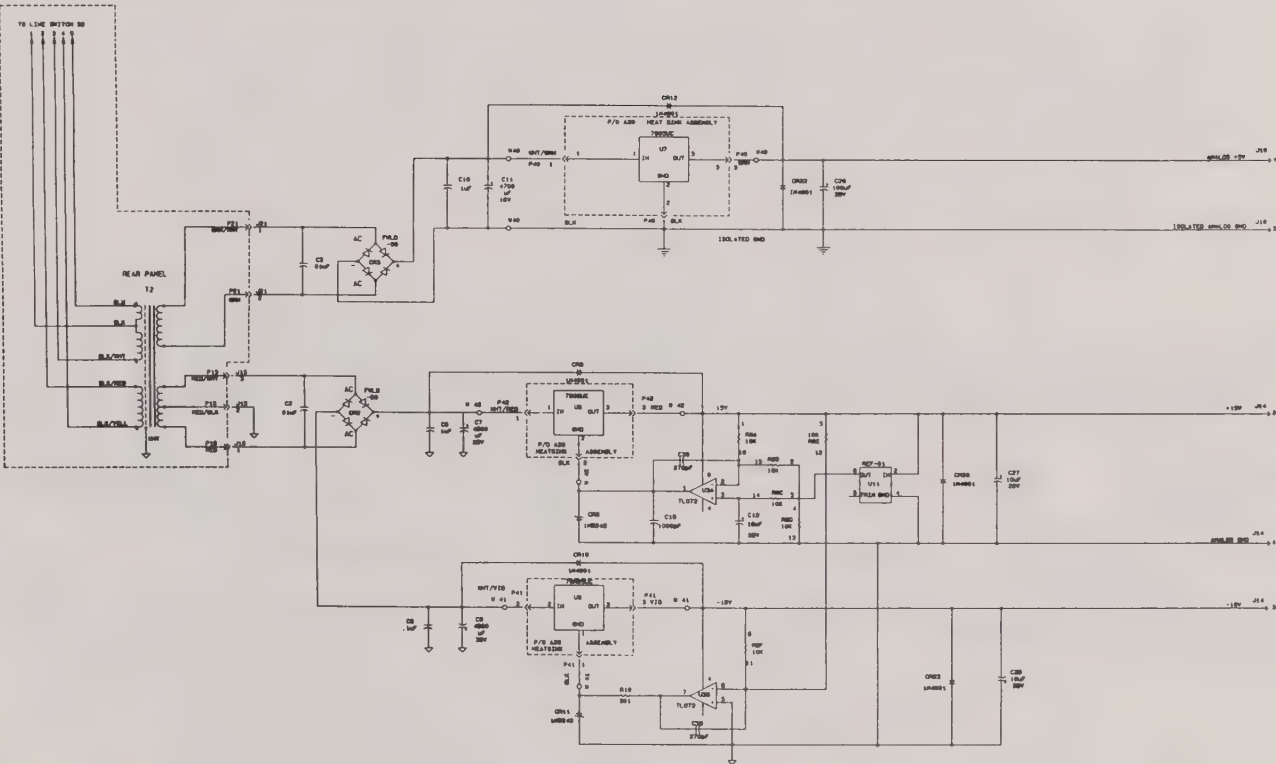


Figure 7-17. Power Supply A11 Schematic Sheet 2.

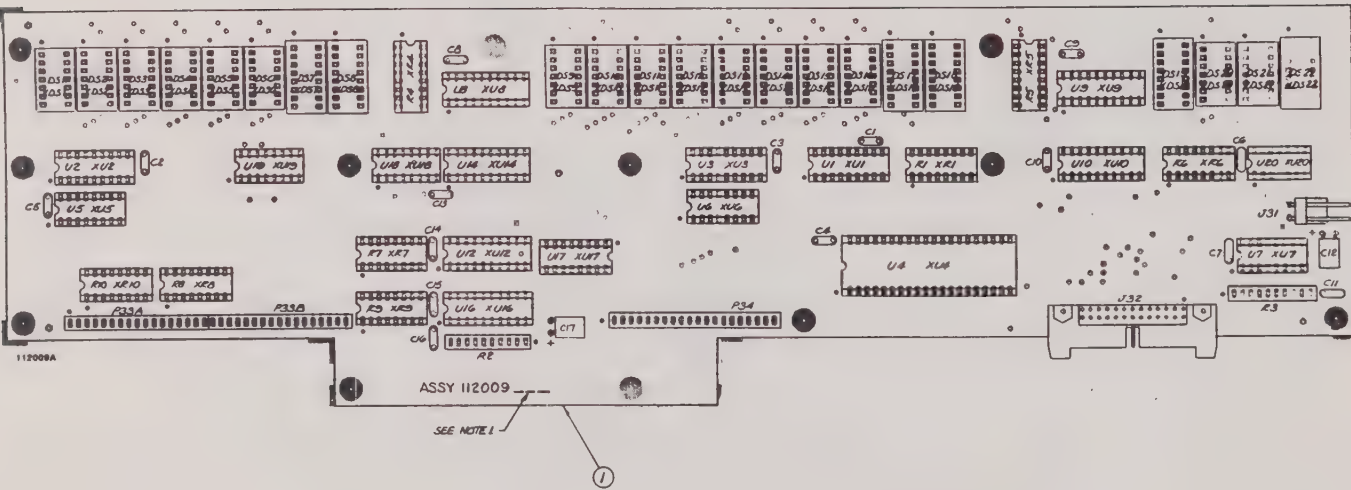


Figure 7-18. Display Board A12 Parts Location Diagram.

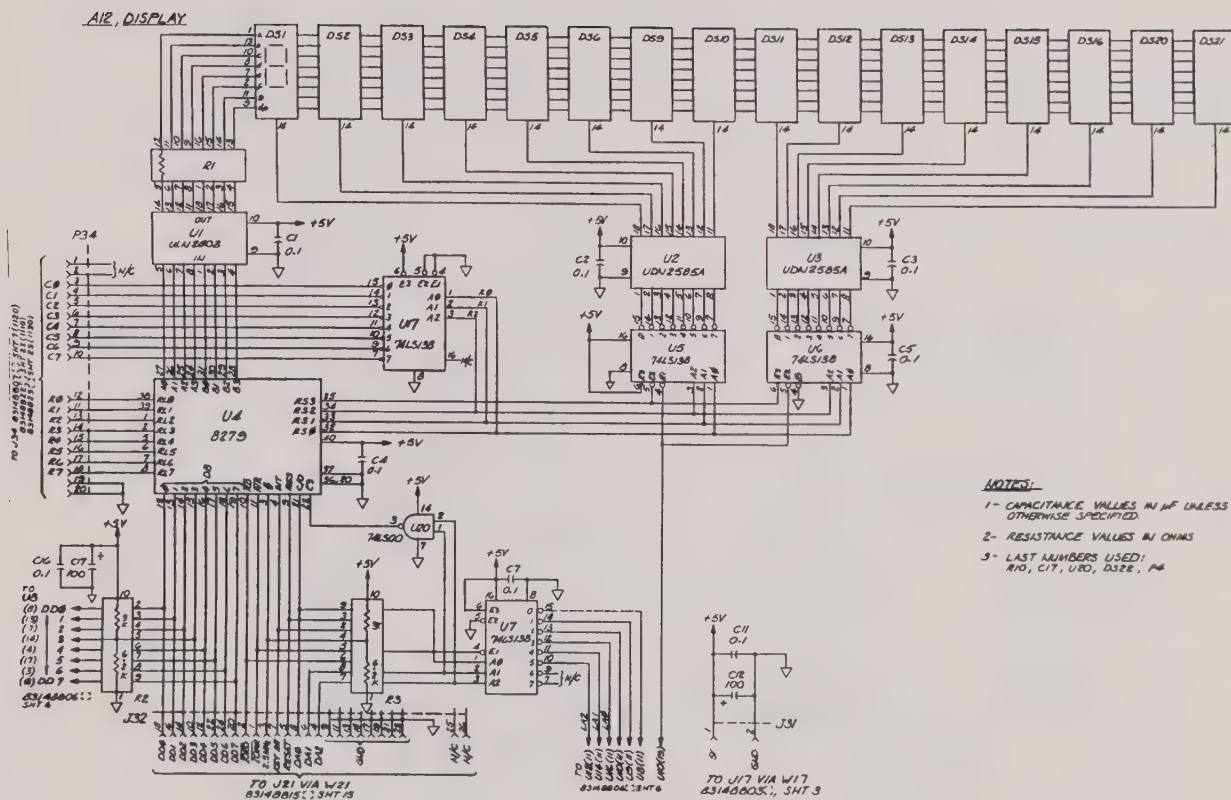


Figure 7-19. Display Board A12 Schematic Sheet 1.



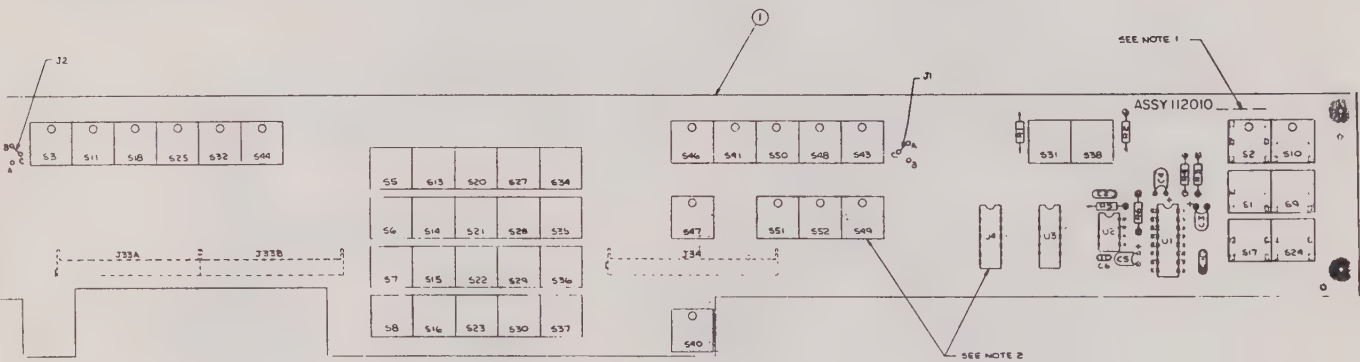
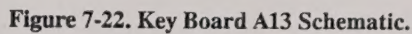
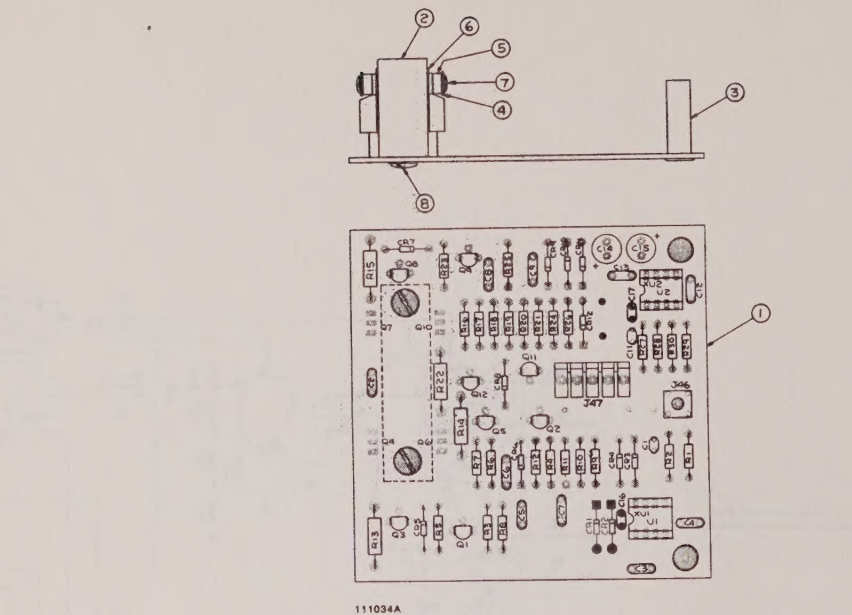


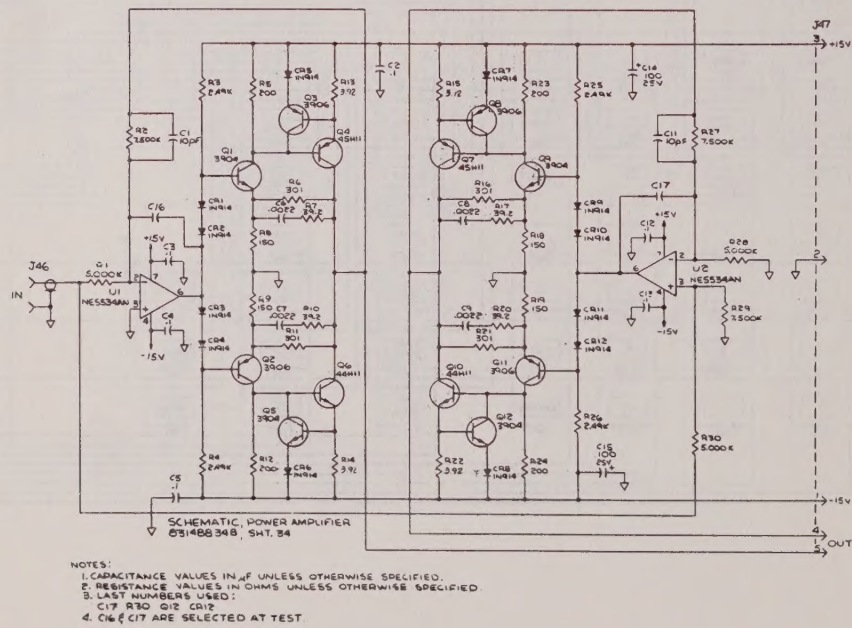
Figure 7-21. Key Board A13 Parts Location Diagram.





NOTE:
C16 & C17 ARE SELECTED AT TEST.

Figure 7-23. Amplifier Board A24 Parts Location Diagram.



NOTES:
1. CAPACITANCE VALUES IN μ F UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS UNLESS OTHERWISE SPECIFIED.
3. LAST NUMBERS USED:
C17 R30 Q12 Q12
4. C16 & C17 ARE SELECTED AT TEST.

Figure 7-24. Amplifier Board A24 Schematic.

WARRANTY

Boonton Electronics Corporation warrants its products to the original purchaser to be free from defects in material and workmanship and to operate within applicable specifications for a period of one year from date of shipment, provided they are used under normal operating conditions. This warranty does not apply to active devices that have given normal service, to sealed assemblies which have been opened or to any item which has been repaired or altered without our authorization.

We will repair, or at our option, replace any of our products which are found to be defective under the terms of this warranty.

There will be no charge for parts, labor, or forward and return normal ground transportation during the first three months of this warranty.*

There will be no charge for parts, labor, or return normal ground transportation during the fourth through twelfth month of this warranty.*

Except for such repair or replacement, we will not be liable for any incidental damages or for any consequential damages, as those terms are defined in Section 2-715 of the Uniform Commercial Code, in connection with products covered by this warranty.

*For overseas shipments, there will be no charge for Air Freight during these specified time periods.

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